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ORIGINAL ARTICLES.

Type and Figured Fossils in the National Museum of Wales.

By F. J. North, D.Sc., F.G.S.

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I. NOTES ON THE ORIGIN AND NATURE OF THE COLLECTIONS.

THE National Museum of Wales has not existed, as a working institution, long enough to have accumulated an extensive series of type and figured fossils, but since recent developments have rendered available for reference geological collections that were hitherto packed in store rooms, it is felt that the time is opportune for the publication of a note concerning the geological material which the Museum possesses, with special reference to the specimens that have been described or figured.

Some of the figured specimens call for special comment because they have interesting associations, and others because the records of locality and horizon were not originally given as accurately as modern methods of research require; it will, therefore, be more convenient to consider the specimens in groups, rather than as a zoologically classified series.

The nucleus of the present Geological Department of the National Museum of Wales was the collection of minerals and fossils in the "Welsh Museum of Natural Arts and Antiquities" (the Cardiff Municipal Museum), which was transferred to the National Museum in 1912, when the Cardiff Museum ceased to exist as a separate institution. Since that time the collections have increased nearly tenfold by donation, purchase, and collection.

It is not necessary to enter into details concerning the history of the collections, but in the following notes attention is drawn to some items of historic interest and to material that is likely to be of use to workers in various branches of palaeontology and palaeobotany.

The first collection of scientific specimens exhibited in Cardiff was that belonging to the "Athenaeum and Mechanics' Institute", which was founded about 1850. The promoters of the Institute were the Rev. W. D. Conybeare, Dean of Llandaff, and Mr. W. H. Nichol. Both gentlemen were keen geologists; Conybeare was, with William Phillips, joint author of the first text book of Geology published in this country—*Outlines of the Geology of England and Wales* (1822), and was, with De la Beche, the first to describe and name the bones of *Plesiosaurus,* while Nichol was a collector of local fossils. Most of the specimens in the Athenaeum appear to have been minerals and fossils, but when, owing to financial difficulties, the Institute was broken up about 1863, the collections were, for the most part, lost, but a few specimens were eventually deposited in the "Glamorganshire and Cardiff Library and Scientific Institution".

The Cardiff Naturalists' Society, which was founded in 1867, had for its principal object the resuscitation of a Museum. The existing collections, and such material as might be subsequently added, were to be transferred to the Cardiff Corporation in order to make a Cardiff Museum, administered by the Free Library Committee. Some part of the Athenaeum collection then still remained, and a few of the geological specimens have survived the vicissitudes through which the Cardiff Museum passed, and are now in the National Museum of Wales. They include a few minerals and fossils, of no particular interest apart from their historic associations.

Among the collections subsequently deposited in the Cardiff Museum may be mentioned the following:—

By W. Adams, F.G.S., Coal Measure fossils from the north-eastern region of the South Wales Coalfield, used by Salter in the palaeontological section of the Survey Memoir, "The Iron Ores of South Wales" (1861).

By W. H. Nichol, Silurian fossils from the Usk Inlier, including specimens collected during the making of the railway and tunnel at Usk. Some of this material was used by J. F. Blake in his work on the Silurian Cephalopoda.

By S. Trump, of Rhymney, Coal Measure fossils from the north-eastern region of the South Wales Coalfield; this collection was used in the compilation of the fossil lists in the first edition of the Survey's Abergavenny Memoir (1900).

Other interesting points connected with the Cardiff Collections are that the nucleus of the present mineral collection was purchased from Robert Etheridge, F.R.S., that in 1893 the late Dr. Henry Woodward and Mr. Martin F. Woodward reported upon the condition and utilization of the material, and that about 1895 many of the fossils were identified by Mr. Henry Woods, of Cambridge. The fossils, mainly Silurian, belonging to J. B. Jukes, were also acquired.

From various causes, which were not peculiar to Cardiff, the Museum frequently fell on evil days, and the geological collections in particular fared badly ; and, bearing in mind the additional fact that it is only within comparatively recent years that the necessity for the accurate recording of the horizon and locality of geological specimens has been realized, it is not surprising to find that when the collections were transferred to the National Museum of Wales, much of the material was, judged by modern standards, worthless : many specimens had been lost, and the number that retained their original labels was small.

In view of the historical interest and scientific importance of many of the old collections the material has been very carefully examined, and those portions which have been satisfactorily re-identified are indicated in the following notes.

Since the advent of the National Museum of Wales considerable additions have been made. Much of the new material has come in the form of small batches either given or collected, and does not call for special enumeration, but among the acquisitions of outstanding interest to research workers are the following :—

(*a*) The collection of fossil plants from the Coal Measures of South Wales, made by Mr. David Davies, M.Sc., F.G.S., during his work on the ecology of the Coal Measure plants.

(*b*) Carboniferous Limestone fossils collected, especially from Barry, by Dr. T. Franklin Sibly when Professor of Geology at Cardiff ; this collection was intended to form the basis of work on the zonal classification of the limestone of the Barry district of Glamorgan, but owing to Dr. Sibly's removal from Cardiff it was not completed, and the material was deposited in the Museum for the use of future workers.

(*c*) A collection of minerals from the old iron mines near Llantrissant made by Mr. G. F. Martyn, and originally deposited in the Cymmer Colliery Workmen's Institute at Porth, by the Committee of which they were given to the National Museum of Wales. This collection is of interest as indicating the range of minerals associated with haematite that resulted from the metasomatic replacement of Carboniferous Limestone.

(*d*) The collection of minerals and fossils, mainly from North Wales, made by Mr. G. J. Williams, I.S.O., F.G.S., of Bangor. This collection, made during a period of about 50 years, is well known to all students of Lower Palaeozoic geology in Wales, and includes many figured specimens. The mineral collection, which includes specimens from many mines not now working, is the most extensive collection of Welsh minerals yet made.

The geological material also includes collections of cephalopoda made by Dr. L. F. Spath, of fossil fishes from the collection of J. Ward, of Longton, of Crag fossils from the collections of the Rev. H. Stanley, and A. Bell, of Ipswich, of rocks illustrating the lithology of South Wales and parts of North Wales, and of rocks and minerals of economic importance in Wales.

II. COAL MEASURE FOSSILS FIGURED OR MENTIONED BY J. W. SALTER IN "IRON ORES OF GREAT BRITAIN. PART III, IRON ORES OF SOUTH WALES" : *Memoirs of the Geological Survey* (1861).

One of the first collections to be deposited (in 1869) in the Cardiff Museum was that made by William Adams, F.G.S., who was, at the time, President of the newly formed Cardiff Naturalists' Society.

The collection consisted principally of Coal Measure fossils from the neighbourhood of Ebbw Vale, which, together with the collection made by Dr. G. P. Bevan, of Beaufort, Monmouthshire, was the basis of the palaeontological section of the Survey Memoir "The Iron Ores of Great Britain. Part III, The Iron Ores of South Wales" (1861). The fossil lists were, as J. W. Salter explained, entirely based upon these two collections, while "the most characteristic specimens only are figured."

In the early days of the Cardiff Museum the importance of registration and labelling was not appreciated, and it was not until the advent of the National Museum of Wales that much of the Adams Collection was registered. Prior to this many specimens had been lost, and very few still retained their labels. Consequently it is not now possible to recognize many of the specimens mentioned or figured by Salter, especially as the illustrations appear, in many cases, to be idealized and were intended to show the character of a species rather than an individual specimen. For example, "*Anthracosia*" *acuta*, pl. ii, fig. 21, is referred to on page 226 as from the Blue Vein or Big Vein of Ebbw Vale (Bevan Collection), and on page 228 as from the Old Coal or Black Vein of Gantre (Adams Collection); while *Spirorbis carbonarius*, pl. ii, fig. 23, is referred to on page 226 as from the Blue Vein or Big Vein of Sirhowy (Bevan Collection), and on page 227 as from the Spotted Vein of Ebbw Vale (Adams Collection). The same applies in several other cases.

The fish remains figured on pls. i and ii cannot now be positively recognized, for the outlines of the matrix have not been indicated, and in most cases the illustrations are generalized. As in the case of many of the invertebrate fossils, if they still exist, which is doubtful, they cannot possibly be re-identified.

The few specimens that can be definitely associated with Salter's figures are as follows :—

BRACHIOPODA.

Athyris planosulcata (Phillips) [G. 409].[1]

Coal Measures : Mine over Bydyllog or Ras Las Coal, Beaufort, Mon.; Bevan Collection.

Salter, "Iron Ores of South Wales" (1861), p. 229, pl. ii, fig. 11.

"Mine" means ironstone ; originally the term was applied to the ore, rather than to the place from which it was obtained ; the latter was a "mine-works".

It is suggested in the second edition of the Abergavenny Memoir that the locality given by Salter as "Beaufort" is in a small gully 900 yards south-east of the reservoir at Llangynidr ; this is about a mile and a quarter north-west of Beaufort Station.

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[1] Numbers in square brackets are the Museum registration numbers.

Buxtonia (*Productus*) *scabricula* (Martin) [G. 393].

Coal Measures : Mine over Engine Coal, Pontypool ; Adams Collection. Salter, ibid., p. 228, pl. ii, fig. 18.

Spirifer bisulcatus Sowerby [G. 329].

Coal Measures : Mine over Engine Coal, Clydach, near Abergavenny ; Adams Collection. Salter, ibid., p. 228, pl. ii, fig. 19.

CEPHALOPODA.

Discites falcatus (Sowerby) [G. 410.2].

Millstone Grit : Rosser Vein Ironstone ; Glan Rhymney, 4 miles north-east of Merthyr Tydfil. Salter, ibid., p. 221, pl. i, fig. 37.

This species is recorded by Salter from both the Adams Collection and the Bevan Collection ; the provenance of the specimen [G. 410.2] has not been recorded.

The " Glan Rhymney " of Salter's list appears as Lan Rhymney on the 1832 edition of the 1 in. ordnance survey map, where the name relates to a farmstead ; and it compares in position to " Lower House " of the present 6 in. map,[1] which is situated near the junction of the Rhymney River with a small tributary Nant-y-Gaseg, about a quarter of a mile north-north-west of Rhymney Bridge Station. The Nant-y-Gaseg on the 6 in. map is the Nant-y-cesyg of the Abergavenny Memoir. The names are singular and plural forms of the same term ; the former signifies the "Stream of the Mare ", and the latter the " Mare's Stream ".

The Rosser Vein Ironstones referred to are the ironstones formerly worked under that name in shales of Millstone Grit age, not the Rosser Vein Ironstone which occurs above the Farewell Rock (in the Coal Measures) of the Merthyr District.

GASTROPODA.

Conularia quadrisulcata Sowerby [G. 386].

Millstone Grit : Rosser Vein Ironstone ; Glan Rhymney ; Bevan Collection. Salter, ibid., p. 221, pl. i, fig. 34.

The specimen has, by some previous curator, been labelled " Ebbw Vale ", but there is no doubt that it was the example used by Salter for the illustration mentioned above.

LAMELLIBRANCHIATA.

Anthracomya pumila Salter [G. 490].

Coal Measures : Mine over Three-Quarter Coal ; No. 6 Pit, Victoria Colliery, Ebbw Vale, Mon. ; Adams Collection.

The Holotype : Salter, ibid., p. 230, pl. ii, fig. 10.

See also Wheelton Hind, " A Monograph on Carbonicola, Anthracomya, and Naiadites," *Palaeontographical Society* (1894–6), p. 108, pl. xvi, fig. 2.

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[1] Glamorgan, VI, S.E., also Abergavenny Memoir, 2nd ed. p. 49.

This and the following specimens of *Anthracomya* were examined by Mr. J. H. Davies and Dr. A. E. Trueman in connexion with their recent work on the Coal Measure mollusca,[1] and they expressed the opinion that the type material includes three specimens [G. 111, G. 490, and G. 491], but that G. 490 is to be regarded as the holotype.

Anthracomya pumila Salter [G. 491].

Coal Measures: Mine over Three-Quarter Coal; No. 6 Pit, Victoria Colliery, Ebbw Vale, Mon.; Adams Collection.

A paratype: Wheelton Hind, ibid., p. 108, pl. xvi, fig. 3.

Anthracomya subcentralis Salter [G. 489].

Coal Measures: Mine over Three-Quarter Coal; No. 6 Pit, Victoria Colliery, Ebbw Vale, Mon.; Adams Collection.

The Holotype: Salter, ibid., p. 231, pl. ii, fig. 9.

See also Wheelton Hind, ibid., p. 109, pl. xvi, fig. 1.

Anthracomya adamsii Salter [G. 683].

Coal Measures: Soap Vein Mine; Pen-y-cae, Mon.; Adams Collection.

The holotype: Salter, ibid., p. 230, pl. ii, figs. 7*a*–7*b*.

See also Davies and Trueman, ibid., p. 233, pl. xvii, figs. 2*a* and 2*b*.

Anthracomya adamsii Salter [G. 488].

Coal Measures: Soap Vein Mine; Pen-y-Cae, Mon.; Adams Collection.

A paratype. Wheelton Hind, ibid., p. 89, pl. xvi, fig. 54.

The "Bevan" Collection.—Reference has been made to the Bevan Collection which Salter consulted during the course of his work, but although, to judge from Salter's lists and the information contained in a paper entitled "On the Geology of the Beaufort and Ebbw Vale District of the South Wales Coalfield", by G. P. Bevan,[2] the collection must have been extensive, inquiries have failed to discover its fate or present whereabouts. It may be that Dr. Bevan gave them to his friend, W. Adams, and that, incorporated into his collection they passed into the Cardiff Museum. That this may have happened to part, at least, of Bevan's material, appears likely from the fact that some of Salter's figured specimens which can now be recognized, are recorded only from the Bevan Collection. The only other clue to their possible destination is in a passage in the paper by Dr. Bevan, to which reference has already been made. He wrote: "Professor Melville has kindly promised to name all my shells more accurately, for which purpose he has my collection with him in Ireland."

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[1] J. H. Davies, F.G.S., and A. E. Trueman, D.Sc., F.G.S., "A Revision of the Non-Marine Lamellibranchs of the Coal Measures, and a Discussion of their Zonal Sequence": *Quart. Journ. Geol. Soc.*, vol. lxxxiii, pt. ii, pp. 210–59.

[2] *The Geologist*, vol. i, 1858, pp. 124–9.

I have been unable to trace "Professor Melville" or to ascertain whether the specimens were returned to Dr. Bevan. Professor Joly and Dr. L. B. Smyth have kindly assisted me in this inquiry.

The "Trump" Collection.—In 1901 the Cardiff Museum acquired the collection made by Mr. S. Trump from the Coal Measures and Millstone Grit at the head of the Rhymney Valley. The specimens had been previously examined by Messrs. Sharman and E. T. Newton, of the Geological Survey, and also by Dr. Wheelton Hind, and they were included in the fossil lists in the first edition of the Abergavenny Memoir, pp. 47–8, but unfortunately, as was the case with the Adams Collection, the material was not adequately labelled, and only a few specimens have been recognized in the Cardiff Museum Collection.

Some of the specimens in the "Adams", "Bevan," and "Trump" Collections are included in the fossil lists in the second edition of the Abergavenny Memoir, p. 135.

III. COAL MEASURE INSECTS.

Archimylacris woodwardi Bolton [27. 177. G1].

(Left fore-wing.)

Carboniferous (*Coal Measures*): Shale overlying No. 2 Rhondda Seam, near base of Pennant Series; Clydach Vale, Glamorgan.

H. Bolton, "On a New Species of Fossil Cockroach, *Archimylacris* (*Etoblattina*) *woodwardi*, from the South Wales Coalfield," GEOL. MAG., 1910, pp. 147–51, Pl. XV, Figs. 1*a* and 1*b*.

H. Bolton, "A Monograph of the Fossil Insects of the British Coal Measures," *Memoirs Palaeontographical Society*, 1921–2, p. 106, pl. vii, fig. 2. Ex coll. David Davies.

Pseudofouquea cambrensis (Allen) [13. 120. G1].

(Counterpart of the holotype, a wing impression.)

Carboniferous (*Coal Measures*): Four Feet Seam, Lower Coal Measures, Llanbradach Colliery, near Cardiff.

H. A. Allen, "On an Insect from the Coal Measures of South Wales," GEOL. MAG., 1901, p. 65, Fig. on p. 66.

H. Bolton, "On some Insects from the British Coal Measures," *Quart. Journ. Geol. Soc.*, vol. lxxii (1916), p. 59, pl. iv, figs. 4–5.

H. Bolton, "A Monograph of the Fossil Insects of the British Coal Measures," *Memoirs Palaeontographical Society*, 1921–2, p. 72, pl. iv, fig. 8*b*.

Ex coll. G. Roblings.

IV. COAL MEASURE PLANTS.

The material collected by Mr. David Davies, M.Sc., F.G.S., of Gilfach Goch, during the course of his work on the ecology of the Coal Measure plants in South Wales, has been deposited in the Museum. It was used in the preparation of the following papers:

"Distribution of the Different Species of Flora and Fauna from the Westphalian and part of the Staffordian Series of Clydach Vale and Gilfach Goch, East Glamorganshire": *Trans. Inst. Mining Engineers*, vol. lix, pt. iii (1920), pp. 183–221.

"The Ecology of the Westphalian and the Lower Part of the Staffordian Series of Clydach Vale and Gilfach Goch (East Glamorgan)": *Quart. Journ. Geol. Soc.*, vol. lxxvii, 1921, pp. 30–74.

Much of the material was identified by the late Dr. Kidston, and after his death the work was continued by Dr. R. Crookall. Since the latter's appointment to the Geological Survey, small portions of the collection have been identified by Mr. R. G. Absalom, M.Sc., and Miss J. Hawkins, B.Sc.

The main interest of this large collection, and the feature in which it differs from any other, is that the material has been systematically collected by one individual, from every horizon where fossiliferous beds occur, in three distinct regions of the coalfield; it is, therefore, of great value in studies relating to the evolution and ecology of the Coal Measure plants and to the correlation of the Coal Measures.

Although the bulk of the collection consists of plants, other groups, insects, fish, and mollusca—are also represented.

Many fossils in this collection have been figured in Kidston's monograph, "Fossil Plants of the Carboniferous Rocks of Great Britain," *Memoirs of the Geological Survey*, 1923, but the specimens so dealt with were retained by Dr. Kidston, and on his death, passed with the remainder of his collection, into the hands of the Geological Survey.

V. CARBONIFEROUS LIMESTONE FOSSILS.

BRACHIOPODA.

The following were described and figured by F. J. North, in "On *Syringothyris* Winchell, and certain Carboniferous Brachiopoda referred to *Spiriferina* D'Orbigny," *Quart. Journ. Geol. Soc.*, vol. lxxvi (1920), pp. 162–227.

Syringothyris principalis North [20. 474. G1].

(A pedicle valve.)

Carboniferous Limestone (K zone): Trot's Corner, Mendip Area. A paratype, North, ibid., p. 182, pl. xi, fig. 1.
Ex coll. T. Franklin Sibly.

Syringothyris principalis North [20. 474. G2].[1]

(A pedicle valve.)

Carboniferous Limestone (K_2 subzone): Howle Hill, Mitcheldean district. The holotype, North, ibid., p. 182, pl. xi, fig. 2.
Ex coll. T. Franklin Sibly.

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[1] This species has recently been re-named *Prosyringothyris Northi* by G. Fredericks, in "Der Apikalaparat der Brachiopoda Testicardines": *Neues Jahrbuch für Mineralogie*, etc., Beilageband LVII, Abt. B, 1927, pp. 1–11.

Syringothyris cuspidata (Martin) mut. *cyrtorhyncha* North [19. 246. G2].

(Specimen showing both valves.)

Carboniferous Limestone (Z_1 subzone) : Avon Section (south side), Bristol. North, ibid., p. 184, pl. xi, figs. 3*a* and 3*b*. Ex coll. F. J. North.

Syringothyris cuspidata (Martin), mut. *cyrtorhyncha* North [20. 474. G4].

(Internal cast of pedicle valve.)

Carboniferous Limestone (Z zone) : Mitcheldean Quarry, Glos. North, ibid., p. 184, pl. xi, fig. 6. Ex coll. T. Franklin Sibly.

Syringothyris cuspidata (Martin), mut. *exoleta* North [20. 474. G3].

(Specimen showing both valves.)

Carboniferous Limestone (C_2 subzone) : Black Rocks, near Sutton, Glamorgan. North, ibid., p. 185, pl. xi, figs. 4*a* and 4*b*. Ex coll. T. Franklin Sibly.

Tylothyris laminosa (M'Coy), mut. γ [24. 474. G5].

(Imperfect pedicle valve.)

Carboniferous Limestone (Z_2 subzone) : Twyn-yr-odin, Glamorgan. North, ibid., p. 200, pl. xiii, fig. 1. Ex coll. T. Franklin Sibly.

Tylothyris laminosa (M'Coy), mut. γ [19. 246. G3].

(Brachial valve.)

Carboniferous Limestone (Horizon γ) : Alps Quarry, Wenvoe, Glamorgan. North, ibid., p. 200, pl. xiii, fig. 2. Ex coll. F. J. North.

Tylothyris laminosa (M'Coy), mut. γ [20. 474. G7].

(Cast of the interior of a pedicle valve.)

Carboniferous Limestone (C_1 subzone = *laminosa* dolomite) ; Collafield, north of Littledean, Glos. North, ibid., p. 200, pl. xiii, fig. 12. Ex. coll. T. Franklin Sibly.

Tylothyris laminosa (M'Coy), mut. γ [20. 474. G8].

(Pedicle valve showing internal structures.)

Carboniferous Limestone (Horizon γ) : Near Lavernock, Glamorgan. North, ibid., p. 200, pl. xiii, fig. 13. Ex coll. T. Franklin Sibly.

Tylothyris subconica subconica North [20. 474. G9].

(Pedicle valve showing internal structure.)

Carboniferous Limestone (D_3 subzone) : Waterhouses, Staffordshire. North, ibid., p. 203, pl. xiii, fig. 15. Ex coll. T. Franklin Sibly.

Spiriferina octoplicata (J. de Sowerby), mut. D [19. 246. G10].

(Specimen showing both valves.)

Carboniferous Limestone (D zone): Parkhill, Derbyshire. North, bid., p. 217, pl. xiii, fig. 8. Ex coll. F. J. North.

Spiriferina octoplicata (J. de Sowerby), mut. δ [20. 474. G6].

(Part of brachial valve.)

Carboniferous Limestone (Horizon γ): Little Island, Barry, Glamorgan. North, ibid., p. 257, pl. xiii, fig. 9. Ex coll. T. Franklin Sibly.

Spiriferina walcotti D'Orbigny [19. 246. G9].

(Internal cast, showing features of pedicle valve.)

Lower Lias: Radstock, Somerset. North, ibid., p. 208, pl. xiii, fig. 14. Ex coll. F. J. North.

COELENTERA.

CLASS ANTHOZOA.

The following are thin sections (and specimens from which they were cut) illustrated by Miss J. M. M. Dingwell, in "On *Cyathoclisia*, a new Genus of Carboniferous Coral," *Quart. Journ. Geol. Soc.*, vol. lxxxii (1926), pp. 12–21, pls. i–iii.

Cyathoclisia tabernaculum Dingwall, Barry type.

Transverse section, pl. iii, fig. 10 [26. 202. G44].
Transverse section, pl. iii, fig. 8 [26. 202. G35].
Longitudinal section, pl. ii, fig. 4 [26. 202. G9].
Longitudinal section, pl. iii, fig. 9 [26. 202. G36].
Transverse section, pl. ii, figs. 1, 3, 5–8 [26. 202. G8, 7, 6, 4, 3, 2 respectively].
Transverse section, pl. ii, fig. 2 [26, 202, G. 14].

Cyathoclisia tabernaculum Dingwall, variety resembling *Clisiophyllum*.

Transverse section, pl. iii, fig. 5 [26, 202, G. 26].

Cyathoclisia tabernaculum Dingwall, *Amygdalophyllum* type.

Transverse section, pl. iii, figs. 1–4 [26. 202. G47, 48, 49, 51] respectively.

All the above are from the Carboniferous Limestone, Horizon ν, Barry, Glamorgan, and the specimens from which they were cut were collected by Dr. T. Franklin Sibly.

PISCES.

Sandalodus morrisi Davis [21. 480. G2].

(Dental plate.)

Carboniferous Limestone (basal light oolite): Pontsticill.

Referred to in "The Geology of the Country around Merthyr", *Memoirs Geological Survey* (1904), p. 21. Ex coll. D. Farr Davies, F.G.S.

VI. SILURIAN FOSSILS FROM SOUTH WALES AND MONMOUTHSHIRE.

CEPHALOPODA.

The following specimens from the W. H. Nichol Collection, placed in the Cardiff Museum in 1870, were described and figured by J. F. Blake in "A Monograph of the British Fossil Cephalopoda, part 1, Introduction and Silurian Species," London (1882).

Orthoceras nicholianum Blake [00. 304].

(Specimen showing part of the shell and part of the siphuncle.)
Silurian (Lower Ludlow Beds): Usk, Mon. Blake, ibid., p. 88, pl. iii, fig. 15.

This specimen is the holotype, and the name adopted by Blake was one that Salter had previously written on the label accompanying the specimen.

Orthoceras excentricum (Sowerby) [01. 2].

Silurian (Wenlock Shale): Clytha, Usk, Mon. Blake, ibid., p. 152, pl. xii, fig. 2.

Gomphoceras gratum Barrande [00. 307].

Silurian (Lower Ludlow Beds): Garcoed, Usk, Mon. Blake, ibid., p. 195, pl. xxiii, fig. 1.

GASTROPODA.

Goniostropha elegans (Sollas) [00. 209*a*].

(Imperfect mould in sandstone.)
Silurian (Wenlock Beds): Rhymney Quarry, near Cardiff. Miss J. Donald, in "On some of the Proterozoic Gasteropoda which have been referred to *Murchisonia* and *Pleurotomaria* with Descriptions of New Sub-genera and Species," *Quart. Journ. Geol. Soc.*, vol. lviii, 1902, p. 321, pl. vii, fig. 4.

The quarry (now spelt Rumney) takes its name from the village of Rumney, which is situated near the mouth of the Rhymney River, about 2 miles east of Cardiff.

This is one of four specimens from the same locality examined by Miss Donald (now Mrs. Longstaff) and referred to in her paper. The type specimen was said to be in the "Bristol Museum", but it does not now appear to be in the collection either at the City Museum or the University Museum.[1]

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[1] On the authority of Dr. H. Bolton and Professor S. H. Reynolds respectively.

The Silurian fossils in the National Museum of Wales also include those from Pen-y-lan, and Rumney in the Cardiff Inlier, mentioned in the Cardiff Memoir.[1]

VII. LOWER PALAEOZOIC FOSSILS, MOSTLY FROM NORTH WALES, FORMERLY IN THE COLLECTION OF G. J. WILLIAMS, I.S.O., F.G.S., OF BANGOR.

ARTHROPODA.

Class Trilobita.

All the following are figured in P. Lake, "A Monograph of the British Cambrian Trilobites," *Palaeontographical Society*, 1906–10.

In some cases the localities given in the monograph are capable of more detailed definition, and in view of the importance of the locality of a fossil, especially a figured specimen, the following notes, in the preparation of which Mr. G. J. Williams has assisted, includes particulars which will enable the find-site to be identified on the 6 in. map.

Microdiscus punctatus Salter [27. 110. G15].

(An internal cast, from which the neck spine is missing.)

Cambrian (Menevian): Near Nine Wells, St. David's, Pembrokeshire. *Cambrian Trilobites*, pt. ii (1907), p. 36, pl. iii, figs. 12 and 12*a*.

Shumardia pusilla (Sars) [27. 110. G16].

(An internal cast; an unusually large specimen.)

Cambrian (Upper Tremadoc): From a small mound on the west side of Amnodd-bwll farmhouse, which is 1 mile south-west of Arenig Station, Merionethshire. *Cambrian Trilobites*, part ii (1907), p. 42, pl. iii, fig. 20.

Parabolina spinulosa (Wahlenberg) [27. 110. G17].

(An external mould.)

Cambrian (Upper Lingula Flags): Rhiw-felen, on Afon Mawddach, about 8 miles north-north-east of Dolgelley, Merionethshire. The specimen obtained from the Dolgelley Beds was accompanied by *Orthis lenticularis*. *Cambrian Trilobites*, part iii (1908), p. 63, pl. vi, fig. 8.

Parabolina spinulosa (Wahlenberg) [27. 110. G18].

(A specimen in which the two points behind the tail are present, but indistinct.)

Cambrian (Upper Lingula Flags): Rhiw-felen, Merionethshire—for locality see above. *Cambrian Trilobites*, part iii (1908), p. 63, pl. vi, fig. 9.

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[1] "The Geology of the Country around Cardiff": *Memoirs of the Geological Survey*, 1912, pp. 8–12.

Parabolina spinulosa (Wahlenberg) [27. 110. G19].

(A broad form, slightly distorted.)

Cambrian (Upper Lingula Flags): Nant Cistfaen, Merionethshire. In the recent 6 in. maps the place-name is spelt Nant y Gist-faen; it is a small stream flowing north-east to join Afon Tryweryn about 9 furlongs south-west of Arenig Station. The horizon is the Lower Dolgelley Beds or the *Parabolina* beds of Fearnsides: "The Geology of Arenig Fawr and Moel Llyfnant," *Quart. Journ. Geol. Soc.*, vol. lxi (1905), pp. 608–40. *Cambrian Trilobites*, part iii (1908), p. 63, pl. vi, fig. 10.

Parabolina spinulosa (Wahlenberg) [27. 110. G20].

(A small, probably young specimen, with short pleural spines.)

Cambrian (Upper Lingula Flags): Llyn Tryweryn.

This specimen was obtained from an exposure in a ditch near the railway at Llyn Tryweryn, about 1¼ miles west-south-west of Arenig Station, Merionethshire. *Cambrian Trilobites*, part iii (1908), p. 63, pl. vi, fig. 11.

Peltura olenoides (Salter) [27. 110. G21].

(An example considerably smaller than the type specimen.)

Cambrian (Upper Tremadoc): Garth Hill, Minffordd, near Portmadoc.

The horizon is the "Garth Hill Beds" of Fearnsides, see "The Tremadoc Slates of South-East Carnarvonshire", *Quart. Journ. Geol. Soc.*, vol. lxvi (1910), p. 162. *Cambrian Trilobites*, part v (1909), p. 101, pl. xii, fig. 5.

Beltella bucephala (Belt) [27. 110. G22].

(A flattened, distorted cranidium.)

Cambrian (Upper portion of Middle Lingula Flags): Nant y Gist-faen, Merionethshire; for locality see remarks under *Parabolina spinulosa*. *Cambrian Trilobites*, part v (1909), p. 107, pl. xii, fig. 13.

Beltella bucephala (Belt) [27. 110. G23].

(Cranidium slightly distorted.)

Cambrian (Upper portion of Middle Lingula Flags): Nant y Gist-faen, Merionethshire; for locality see remarks under *Parabolina spinulosa*. *Cambrian Trilobites*, part v (1909), p. 107, pl. xii, fig. 14.

Beltella bucephala (Belt) [27. 110. G24].

(Cranidium and part of thorax.)

Cambrian (in passage beds from Middle to Upper Lingula Flags): Nant y Gist-faen, Merionethshire; for locality see remarks under

Parabolina spinulosa. Cambrian Trilobites, part v (1909), p. 107, pl. xii, fig. 15.

Beltella verisimilis (Salter) [27. 110. G25].

(Cranidium and three thoracic segments.)

Cambrian (Upper part of Middle Lingula Flags): Near the junction of Nant y Gist-faen and a small stream which enters it from the south-east.

Near the junction of the Middle and Upper Lingula Flags there are some soft beds which have given rise to a pool and a small waterfall; this is the "pool" referred to in Lake's monograph, p. 107. *Cambrian Trilobites,* part v (1910), p. 107, pl. xiii, fig. 4.

Beltella verisimilis (Salter) [27. 110. G26].

(Cranidium and part of thorax.)

Cambrian (upper part of Middle Lingula Flags): The locality given in Lake's monograph as "above pool, Trinant" is the same as that of the previous specimen, 27. 110. G11. Trinant is a general name for the locality, because there, three streams unite. *Cambrian Trilobites,* part v (1910), p. 107, pl. xiii, fig. 5.

Dikellocephalina furca (Salter) [27. 110. G27].

(Left hand portion of cranidium and part of thorax.)

Cambrian (Upper Tremadoc): Garth Hill, Minffordd, near Portmadoc; for horizon see note under *Peltura olenoides. Cambrian Trilobites,* part v (1910), p. 118, pl. xiv, fig. 11.

Apatokephalus serratus (Bolck) [27. 110. G28].

(Cranidium only.)

Cambrian (Upper Tremadoc): Amnodd-Wen, Merionethshire.

Amnodd-Wen is a farm about ¾ mile south-west of Arenig. *Cambrian Trilobites,* part v (1910), p. 120, pl. xiv, fig. 14.

ARTHROPODA.

Class Crustacea.

Peltocaris salteriana T. R. Jones and H. Woodward [27. 110. G29].

(Parts of the two valves of one individual.)

Cambrian (Lower Tremadoc): Quarry on stream flowing north from Moel Llyfnant, Merionethshire; this is a small quarry near the junction of Nant y Gist-faen and a stream that enters it from the south-east, and is about 7 miles east-south-east of Ffestiniog.

The holotype. T. R. Jones and H. Woodward, "On some Palaeozoic Phyllopodous and other Fossils," GEOL. MAG., 1893, p. 199, pl. x, figs. 1*a* and 1*b*.

Ceratiocaris insperata Salter [27. 110. G30].

(Part of a telson with three caudal spines—two specimens, one of which is the counterpart of the other.)

Ordovician (Arenig): Llechwedd Deiliog Quarry, 6 miles east of Ffestiniog, Merionethshire.

T. R. Jones and H. Woodward, ibid., p. 202, pl. x, figs. 8*a*, 8*b*, and 8*e*.

Dipterocaris etheridgei T. R. Jones and H. Woodward
[27. 110. G31].

(Two associated valves.)

Silurian (Wenlock Beds): Pen-y-Glog Quarry, Corwen, Merionethshire.

(This is now the Corwen Slate Mine, the name Pen-y-Glog does not appear on recent ordnance maps.)

T. R. Jones and H. Woodward, ibid., p. 199, pl. x, fig. 3.

Aptychopsis williamsi T. R. Jones and H. Woodward.
[27. 110. G32].

(One valve.)

Silurian (Wenlock Beds): Locality given as Harp Hollow, near Welshpool; this is near the "Welsh Harp" (of the 6 in. map), about 2 miles east of Welshpool.

The holotype, T. R. Jones and H. Woodward, ibid., p. 201, pl. x, fig. 7.

GASTROPODA.

Conularia sp. [27. 110. G33].

(A fragment resembling an example of *Aptychopsis*.)

Ordovician (Arenig): Llechwedd Deiliog Quarry, 6 miles east of Ffestiniog, Merionethshire.

T. R. Jones and H. Woodward, ibid., p. 199, pl. x, figs. 2*a* and 2*b*.

BRYOZOA.

Thamniscus antiquus Vine [27. 110. G34].

(Branching zoarium in fine-grained volcanic ash.)

Ordovician (Bala): Locality given as "Middleton Hill, Welshpool," but actually it is the north-western extremity of Bulthy Hill, near Middletown, about 5 miles north-east of Welshpool.

The holotype, figured by G. R. Vine, in "Notes on species of *Phyllopora* and *Thamniscus* from the Lower Silurian Rocks near Welshpool, Wales," *Quart. Journ. Geol. Soc.*, vol. xli (1885), p. 111, fig. 2*a*.

(Ex coll. J. Bickerton Morgan, of Welshpool, by whom the specimen was collected and sent to G. R. Vine.)

Phyllopora tumida Vine [27. 110. G35].

(Fragment of zoarium.)

Ordovician (Bala): Locality given as "Wern-y-seadog" (= Wern Scadog), Llanfyllin; but in a paper in *Collections Historical and Archaeological relating to Montgomeryshire*, part xxxvi, April, 1885, pp. 151–2, J. Bickerton Morgan, in whose collection the specimen originally was, referred to the discovery of an example of *Phyllopora* (which was sent to G. R. Vine) a little to the north-west of a moated mound called Tomen-y-Cefn-lle-oer. This spot is about 1½ miles north-west of Llanfyllin; 6 in. sheet, Montgomery ix, north-east.

The holotype, G. R. Vine, ibid., p. 109, figs. 1*a* and 1*b*. (Ex coll. J. Bickerton Morgan, of Welshpool.)

Phyllopora tumida Vine [27. 110. G36].

(Fragment of zoarium.)

Ordovician (Bala): For note concerning locality see *Phyllopora tumida*.

A paratype: mentioned by G. R. Vine, ibid., p. 109. Ex coll. J. Bickerton Morgan, of Welshpool.

Pinnatopora sedgwickii Shrubsole [27. 110. G37].

(Impression of the cell-bearing face.)

Ordovician (Bala): Garth Gell, South of Corwen.

The locality is a roadside quarry immediately south of the bridge over the Dee at Corwen.

The holotype. Referred to as *Pinnatopora sedgwickii* by G. W. Shrubsole and G. R. Vine, in "The Silurian species of *Glanconome*, and a suggested classification of the Palaeozoic *Polyzoa*," *Quart. Journ. Geol. Soc.*, vol. xl (1884), p. 330.

Figured by R. Etheridge, jun., as *Ramipora hochstetteri* Toula, var. *carinata*, R. Etheridge, jun., in "On the Occurrence of the Genus *Ramipora* (Toula) in the Caradoc Beds of the Neighbourhood of Corwen," GEOL. MAG., 1879, pp. 241–4, Pl. VI, Fig. 1.

In his paper, Etheridge pointed out that the specimen and others like it, differed from *Glauconome disticha* Goldfuss, with which they had previously been confounded.

VIII. JURASSIC FOSSILS AND ROCKS.

Class Reptilia.

DINOSAURIA.

Brontozoum thomasi Sollas [00, 628].

(Slab, with five footprints, three made by the left foot and two by the right foot.)

Trias (Dolomitic Conglomerate): Newton Nottage, Glamorgan.

The holotype. J. W. Sollas "On some three-toed footprints from the Triassic Conglomerate of South Wales," *Quart. Journ. Geol. Soc.*, vol. xxv (1879), p. 511, and illustration on p. 512.

The material (fossils and rocks) referred to by catalogue numbers in Mr. J. F. Jackson's paper on "The Junction Beds of the Middle and Upper Lias on the Dorset Coast," *Quart. Journ. Geol. Soc.*, vol. lxxxii (1926), pp. 480–525, is preserved in the Museum, under accession numbers [26. 134] and [26. 135].

IX. Classified List of Type and Figured Specimens.

COELENTRA.

Class Anthozoa.

Cyathoclisia tabernaculum Dingwall, Barry type. (The holotype) Carboniferous Limestone.

Cyathoclisia tabernaculum Dingwall, *Amygdalophyllum* type. (The holotype) Carboniferous Limestone.

ARTHROPODA.

Class Trilobita.

Apatokephalus serratus (Bolck); Cambrian (Upper Tremadoc).
Beltella bucephala (Belt); Cambrian (Middle Lingula Flags).
Beltella verisimilis (Salter); Cambrian (Middle Lingula Flags).
Dikellocephalina furca (Salter); Cambrian (Upper Tremadoc).
Microdiscus punctatus (Salter); Cambrian (Menevian).
Parabolina spinulosa (Wahl.); Cambrian (Upper Lingula Flags).
Peltura olenoides (Salter); Cambrian (Upper Tremadoc).
Shumardia pusilla (Sars); Cambrian (Upper Tremadoc).

Class Crustacea.

Aptychopsis williamsi T. R. Jones and H. Woodward. (The holotype); Silurian (Wenlock).
Ceratiocaris insperata Salter; Ordovician (Arenig).
Dipterocaris etheridgei T. R. Jones and H. Woodward; Silurian (Wenlock).
Peltocaris salteriana T. R. Jones and H. Woodward. (The holotype); Cambrian (Lower Tremadoc).

Class Insecta.

Archimylacris woodwardi Bolton; Coal Measures.
Pseudofouquea cambrensis (Allen); Coal Measures.

BRACHIOPODA.

Athyris planosulcata (Phillips); Coal Measures.
Buxtonia (*Productus*) *scabricula* (Martin); Coal Measures.
Spirifer bisulcatus (J. de C. Sowerby); Coal Measures.
Spiriferina octoplicata (J. de C. Sowerby), mut. D; Carboniferous Limestone.
Spiriferina octoplicata (J. de C. Sowerby), mut. δ; Carboniferous Limestone.
Spiriferina walcotti (D'Orbigny), (internal cast); Lower Lias.
Syringothyris cuspidata (Martin), mut. *cyrtorhyncha* North; Carboniferous Limestone.
Syringothyris cuspidata (Martin) mut. *exoleta* North; Carboniferous Limestone.
Syringothyris principalis North. (a paratype); Carboniferous Limestone.
Syringothyris principalis North. (The holotype); Carboniferous Limestone.
Tylothyris laminosa M'Coy, mut. ν; Carboniferous Limestone.
Tylothyris subconica subconica North; Carboniferous Limestone.

BRYOZOA.

Phyllopora tumida Vine (the holotype); Ordovician (Bala).
Pinnatopora sedgwickii Shrubsole (the holotype); Ordovician (Bala).
Thamniscus antiquus Vine (the holotype); Ordovician (Bala).

MOLLUSCA.

Class Gastropoda.

Connularia quadriculcata Sowerby; Millstone Grit.
Goniostropha elegans (Sollas); Silurian (Wenlock).

Class Lamellibranchia.

Anthracomya adamsii Salter (the holotype); Coal Measures.
Anthracomya adamsii Salter (a paratype); Coal Measures.
Anthracomya pumila Salter (the holotype); Coal Measures.
Anthracomya pumila Salter (a paratype); Coal Measures.
Anthracomya subcentralis Salter (the holotype); Coal Measures.

Class Cephalopoda.

Cyrtoceras contrarium Barrande; Silurian (Wenlock Shale).
Discites falcatus (J. de C. Sowerby); Millstone Grit.
Gomphoceras gratum Barrande; Silurian (Lower Ludlow).
Orthoceras excentricum (J. de C. Sowerby); Silurian (Wenlock Shale).
Orthoceras nicholianum Blake (the holotype); Silurian (Lower Ludlow).

VERTEBRATA.

Class Reptilia.

Brontozoum thomasi Sollas (footprints) (the holotype); Trias.

Class Pisces.

Sandalodus morrisi Davis; Carboniferous Limestone.

Pleistocene Marine Gravels at Eye, Northamptonshire.

By Professor J. E. Marr, Sc.D., F.R.S., F.G.S., and W. B. R. King, M.A., F.G.S.

THE section was visited by us in company with Dr. H. H. Thomas, of the Geological Survey, and F. A. Marr, Esq., in May, 1927.

This is the best section which we have yet seen of the shell-bearing gravels which form part of the deposit frequently spoken of as the "March gravels". These shell-bearing gravels are proving to be of much wider extent than was originally supposed.

Eye is about 3 miles north-east of Peterborough. The pit is situated just north of Eye Railway Station and the ground level is only a few feet above fen level.

The pit is now being worked in two main divisions, the northerly being entirely in Pleistocene deposits, while the southern or south-eastern part is mainly in Oxford Clay overlain by thin deposits of Pleistocene (some 15 feet thick) which we believe to be glacial boulder clay. In the northern pit about 20 feet of stratified Pleistocene beds are capped by the presumed Boulder Clay.

In the southern pit this clay is mixed and much contorted with wisps of gravel while the junction with the underlying Jurassic clays is very uneven and it is often difficult to decide the exact line of junction.

In the northern pit the main face exhibits well-bedded strata of gravel, sand, and loam, parts of which are markedly falsebedded but otherwise undisturbed until we approach the summit. These beds consist in the main of flint gravel, but marine shells are exceedingly abundant; non-marine shells although present are distinctly rare; large pieces of drift-wood such as are common on the sea shore are in fair abundance, while mammalian bones are quite frequent. Boulders of various far-travelled rocks occur, of which we obtained specimens of hornblende-schist, andesite, and silicified oolite. Large blocks of limestone of Oxford Clay age are common; these will be alluded to in the sequel.

The abundance of small marine shells in the highest part of the deposit may indicate the oncoming of cold conditions.

In parts of the section these gravels are succeeded by a deposit of clay which appears to be continuous with that in the southern part of the pit.

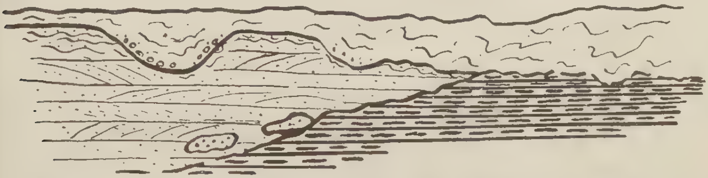

Fig. 1.—Diagrammatic section showing the relationship of the different strata seen at Eye.

This chocolate-coloured rather sandy clay is seen resting on the gravels which are contorted for some depth beneath it, and in two cases marked channels in the underlying gravels are filled with this clay, while the sides of the channels are lined with gravel and sand which has been dragged in.

These phenomena strikingly resemble those described by one of us from the Travellers' Rest pit at Cambridge. In the latter case the gravels are non-marine.

In considering the significance of this section we would notice the light thrown on the origin of the gravels and the probable oncoming of glacial conditions after their deposition.

The evidence seems to us to favour the marine origin of the gravels as opposed to their formation as fluvio-glacial outwash deposits. The nature of the accumulations themselves, the occurrence of a large number of marine shells in a perfect state of preservation and the frequent occurrence of drift-wood is strongly suggestive of a typical raised beach (a view in which Dr. Thomas concurred).

This view seems to be strongly confirmed by the occurrence of the large blocks of Oxfordian limestone already mentioned. These blocks are found abundantly, particularly at the base of the gravels: they are mostly flat slabs of large size, one being 3 feet in diameter, and they are not appreciably rounded by water action. Though not in situ they have not been carried far and appear to be due to the breaking up of one of the bands in the Oxford Clay without appreciable transportation. They are bored by *Pholas*, the borings being very numerous, and although we did not find any shells in any of them *Pholas* shells are quite common in the deposit above and indicate that these borings were not formed in Jurassic times, but are contemporaneous with the deposits, thus indicating the truly marine character of the latter.

A similar case was described by Professor H. G. Seeley at Wimblingdon.[1] The *Pholas*-bored limestone in this case was in situ with the shells remaining in the borings.

As regards the question of the glacial origin of the clay, we will admit that it is not normal boulder clay, but on the other hand it is far from being a normal marine deposit and the nature of the clay and its mode of occurrence, cutting down into and disturbing the underlying deposits, whether Jurassic or Pleistocene, strongly suggested to us and to Dr. Thomas its glacial origin.

Origin of the Relict Fauna of Lough Neagh.

By Professor J. Kaye Charlesworth, D.Sc., Ph.D., F.G.S.

LOUGH NEAGH is one of the numerous lakes possessing a few species, either identical with or differing but slightly from true marine forms living in the present seas. The relicts of Lough Neagh are the pollan, *Coregonus pollan*, and the shrimp, *Mysis relicta* (a near relative of the marine *Mysis oculata*). They have been described by Dr. R. F. Scharff [2] and Professor W. Dakin [3] and Miss M. Latarchie.

Relict lakes have a very considerable distribution, occurring especially in Scandinavia, Finland, North-West Russia, North Germany, and North America. Since their discovery about the middle of the last century, they have been the subject of an extensive literature, the earlier portion of which is ably reviewed in R. Credner's monograph of 1888.[4] It is now generally held that the relict lakes of North-West Europe and North America have been derived from the late-glacial seas which covered the regions in which they lie, in the case of North America from the Champlain Sea, in the case of North-West Europe from the Yoldia Sea and its successor, the Ancylus Lake. It is supposed that the waters of these lakes, now harbouring the relict forms, became detached from the larger masses of water by the late-glacial isostatic uplift of the land and the consequent emersion of the lake areas, and that the marine species in the waters separated in this way have gradually and of necessity adjusted themselves to the freshwater conditions.

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[1] *Q.J.G.S.*, 1866, p. 473.

[2] E.g. *European Animals*, 1907, p. 27.

[3] *Proc. Roy. Irish Acad.*, xxx, Sect. B (1913), p. 81.

[4] Petermann's *Geog. Mitt.*, *Erg. Hefte* 86 and 89 (1888).

While for the lakes of the regions just referred to nothing would seem simpler and more conclusive than the suggested origin, there remain a number which, though possessing a similar relict fauna, are by common consent excluded from the purview of that explanation, as during no part of late or post-glacial time have the tracts in which they occur been covered by the sea or by a marginal extension of the sea. Among these exceptional instances are certain lakes of the northern strip of the German Plain, described by M. Samter and W. Weltner,[1] and an occasional lake in Ireland, including Lough Neagh. For these, in the absence of any other satisfactory explanation, it has been customary to assume a wandering of the marine forms from the main seas by means of the connecting rivers, though how the migration was effected and why only a certain and small number of such lakes and streams should have been so favoured are perhaps less clear.

For Lough Neagh I have during the past six or seven years thrown out a suggestion which, in the course of some reading a few weeks ago, I was glad to find had also been entertained by Professor A. G. Högbom, of the University of Upsala.[2] Emboldened by this independent discovery I now venture to introduce the idea to those British workers who may not have seen Professor Högbom's original paper, more especially as research in recent years into the glacial geology of the north of Ireland has given a clue which, unknown to Professor Högbom, greatly increases the force of his hypothesis.

In the paper to which reference has just been made Professor Högbom contended that the Baltic Glacier in its readvance southward and eastward pushed before it the extra-glacial, marine waters against and on to the rising ground south and east of the Baltic to form a series of saline—later, by influx of land drainage, brackish—marginal lakes, from which the relict fauna of the relict lakes was directly inherited.

This method of accounting for such forms in lakes above the generally accepted upper limit of the late-glacial seas may be extended to Lough Neagh, as was, indeed, done by Professor Högbom, for not only has this lake by common consent at no time been inundated by a post-glacial sea (its surface level is about 50 feet, the height of the raised beach along the north Irish coast about 20 feet above sea-level), but, and of this

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[1] *Zool. Anzeiger*, xxiii, 1900, p. 683; xxv, 1902, p. 222; xxvii, 1904, p. 676.

[2] *Bull. Geol. Inst. Univ. Upsala*, xiv, 1917, p. 251.

Professor Högbom was unaware, it has also come within the influence of a readvance of ice from the sea, which, as will be readily appreciated, is an indispensable condition for the inclusion of sea water in such marginal glacial lakes, since an uninterrupted ice-recession from a land area can never isolate masses of sea water from the ocean.

A readvance of the Scottish Ice along the northern coast of Ireland was proved a few years ago by Dr. A. R. Dwerryhouse [1] and myself,[2] and has been extended more recently [3] round the eastern coast as far south as Belfast Lough. During this oscillation, the ice converged upon the coastal tracts of N.E. Ireland, on the north encroaching upon the lower part of the valley of the Bann, on the east sweeping up Belfast Lough and the lower reaches of the Lagan valley. It impounded the normal drainage of the country to form a vast lake, whose surface lay roughly about 100 feet above the present sea level, the lake discharging by Poinzpass and Newry to Carlingford Lough.

It is suggested that during this advance the Scottish Ice drove before it the marine waters of the coastal areas over which it flowed, merging them, together with their faunal content, in the earliest waters of glacial Lough Neagh. This huge, though relatively very shallow, lake, by constant additions from the land drainage of the ice-free areas around it and the meltwaters from the ice-edge impounding it, would be subject to a rapid and uninterrupted freshening, resulting in the extermination of all species not endowed with considerable powers of adaptation, such as would seem to have been possessed by the two relict forms of the present Lough Neagh, if one may judge from their wide distribution in other lakes of this kind. In strong agreement with this view of an early introduction of *Mysis relicta* into Lough Neagh under glacial conditions, is the sub-Arctic nature of this species, which was early pointed out by S. Lovén.

The explanation in this note is offered merely as a suggestion and a basis for discussion by biologists and geologists. If the former are satisfied with the migration of these forms up the post-glacial River Bann—though in this case, in the opinion of the writer, an insuperable difficulty is presented by a number of waterfalls, coincident in position with Tertiary basalt dykes and the present weirs—then this theory may be regarded as superfluous or as an alternative only. Should they feel reluctant, however, to accept that view, but feel themselves compelled to adopt it as geologists deny a post-glacial submergence of the area in question, then the present theory may serve as a welcome means of bringing Lough Neagh and its somewhat anomalous position into line with those lake depressions whose late-glacial history renders their relict character so readily understandable.

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[1] *Q.J.G.S.*, lxxix, 1923, p. 352.

[2] *Proc. Roy. Irish Acad.*, xxxvi, Sect. B, 1924, p. 294.

[3] *Trans. Roy. Soc. Edin.*, lv, 1926, p. 45.

Researches into the glacial geology of western Ireland, as yet unpublished, facilitate the extension of this explanation to the remaining relict lakes of Ireland, Loughs Erne and Derg.

An Upper Carboniferous Fauna from the Amotape Mountains, North-Western Peru.

By H. Dighton Thomas, M.A. (Cantab.), Sedgwick Museum, Cambridge.

(*Continued from p. 162.*)

(PLATES VI–VIII.)

FAMILY NUCULIDAE.

Genus Nucula Lamarck.

Nucula sp. cf. *anodontoides* Meek ?

(Pl. VI, Figs. 1–1*b*.)

THERE are two well-preserved internal moulds in the collection which are very close indeed to the forms referred to Meek's species by Girty, but unfortunately nothing is known of the external ornamentation of the Peruvian specimens.

Diagnosis.—The valves are small, equivalve, inequilateral, oval, moderately inflated. The greatest height is anterior to the umbo, and three-fifths the length. The umbones are prominent, incurved, gibbous, placed at about one-quarter of the length from the posterior end. The posterior and the ventral margins are both smoothly rounded; the anterior margin is convex below but sub-truncate above, and makes an obtuse angle with the dorsal border.

The hinge is one-half of the length of the valves—the teeth anterior to the umbo number about nine, and those posterior to the umbo are twelve in number. Beneath the umbo the teeth are narrower and more closely arranged than away from it, and apparently there is no interruption of the denticles by the chondrophore. The anterior and the posterior parts of the hinge meet in a wide obtuse angle below the umbo.

One of the casts shows the muscular system. The posterior adductor scar is marginal and oval, with its longer axis in the vertical. The entire pallial line is somewhat removed from the ventral border. The anterior adductor impression is larger than the posterior and is oval, and is placed just below and parallel to the upper, sub-truncate part of the anterior margin. Just anterior to it and immediately posterior to the junction of the anterior margin with the hinge is the small pedal scar (more distinct than the adductor). Further muscles in the umbonal region are represented.

There, protuberances due to them cause a Y-shaped depression to occur, the shaft of the Y being directed obliquely in an antero-ventral direction. Between the arms of the Y is a small, oval scar, elongate vertically. Three very small oval scars occur on an elliptical, slightly protuberant area which marks off the anterior margin of the shaft of the Y, while a fourth, nearly circular, small scar lies above that raised region. Another raised area (elliptical except that it is pointed at the ends of the longer axis) limits the posterior margin of the Y—it is rather larger than the other area.

The shell appears to have been thick since each of the casts shows a more or less carinate edge on the dorsal margin beyond the hinge-line. A small depressed area, marked off by the well-defined umbonal slope, occurs on the cast behind the unbones—it shows four fine concentric striae which can be traced just over the slope. A much less well-defined area occurs anterior to the umbo.

The casts are smooth except for four very faint, concentric rings (= growth-striae).

Remarks.—The only difference between the Peruvian forms and the Oklahoma specimens referred to *N. anodontoides* Meek ? by Girty (**12**,[1] pl. xiii, figs. 1–5) appears to lie in the slightly greater number of hinge teeth in the former, but that hardly seems sufficient to separate the species. In all other ways (size, shape, inflation, and, as far as can be judged from the smoothness of the casts, ornamentation) the two agree very well.

Locality.—Goniatite Bed, Pariñas Quebrada.

FAMILY LEDIDAE.

Genus Leda Schumacher.

Leda browni sp. nov.

(Pl. VI, Figs. 2–4; Pl. VII, Figs. 2, 2*a*.)

This species is represented by twenty-one specimens, of which several are young forms.

Diagnosis.—The shell is large, equivalve, very inequilateral, the posterior part very much produced; closed all round. The greatest height occurs below the umbones, and is equal to about two-fifths of the length. The inflation is moderate, somewhat variable, at a maximum below the umbo slightly above the mid-height.

The umbones are small, incurved, directed posteriorly, and project only slightly above the hinge-line; they are placed at about two-fifths of the length from the anterior end.

The anterior part of the hinge, with several (probably about ten) small teeth, makes a very wide obtuse angle with the posterior part, which bears ten or eleven teeth—neither set of teeth extends far along the hinge-line.

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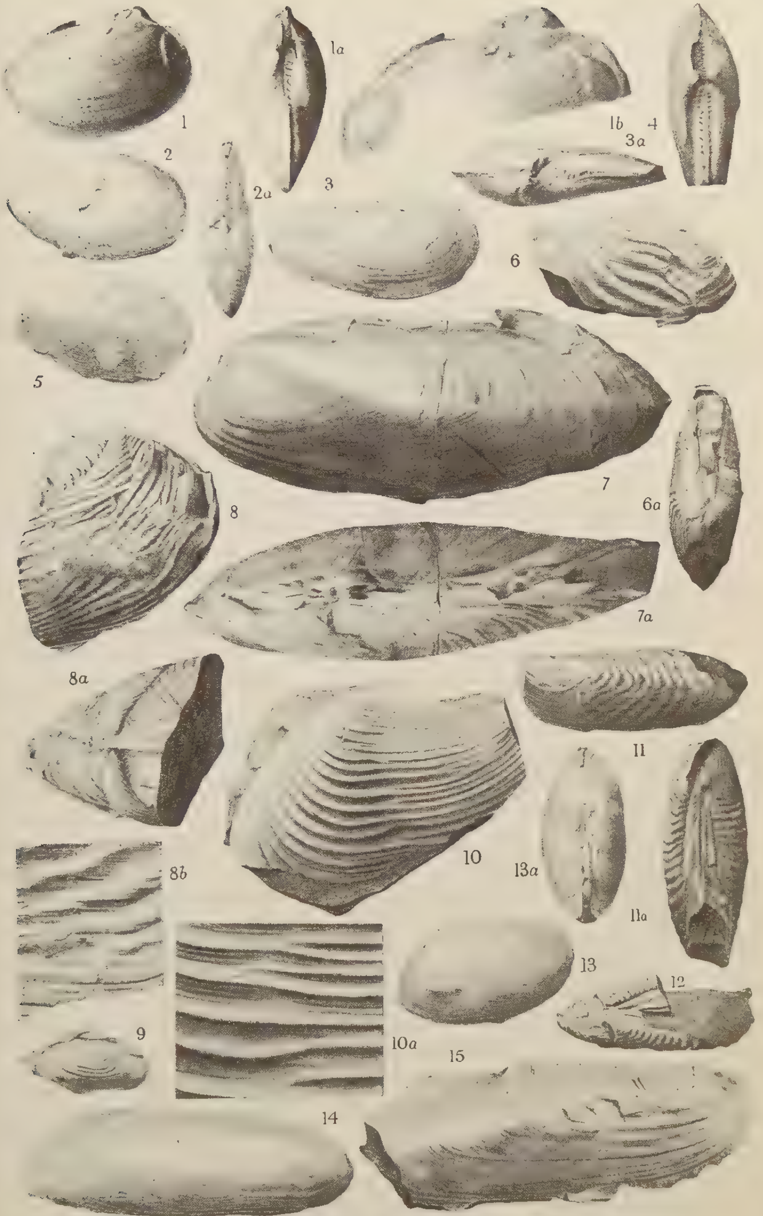
[1] The figures in heavy type refer to the bibliography at the end.



C.B.B. *del.*

PERUVIAN CARBONIFEROUS LAMELLIBRANCHIA.

[*To face p. 216.*

The anterior end is large, rounded, and quadrate. The ventral margin is long, convex, with a continuous passage into the short convex posterior margin. The junction of the latter with the straight-inclined dorsal margin is rounded. A well-marked rounded ridge runs posteriorly from the umbo; above it the valve is concave to the cardinal line.

The surface ornamentation consists of thin concentric striae parallel to the margins of the shell, and separated by flat interspaces, each of which very slightly rises dorsally to a maximum at the next stria. The lunule is small and indistinct.

Internal casts (smooth except for concentric lines corresponding to growth-striae) show a small, very shallow furrow in the umbonal cavity, slightly concave anteriorly at the umbo. This passes ventrally into an obscure, shallowing, and broadening depression, which traverses the cast for three-quarters of its height and which is only slightly directed posteriorly. The furrow corresponds to the ridge on the inside of the valve characteristic of the Palaeozoic Ledae and noted by various authors, e.g. Hind (**14,** p. 194) and Girty (**12,** p. 109).

The young forms, numerous in the collection, show certain features slightly different from those of the adult stages—in the former the anterior end is a little shorter and is less quadrate, the posterior end is somewhat narrower in the dorso-ventral direction, and the umbones are higher. In addition, there is in one or two specimens an almost imperceptible constriction near the posterior end which causes the ventral margin in those forms there to straighten. These features are shown in the umbonal region of the mature individuals.

Remarks.—Three Ledidae are recorded from South American Carboniferous rocks. Derby (**2,** p. 496) mentions (without figures) from Brazil *Yoldia subscitula* Meek and Hayden and *Leda* sp. similar to *L. obesa* White, while Cowper Reed (**27**) figures *L.* cf. *bellistriata* Stevens from Argentina. The first-named (**23,** pl. ii. figs. 4*a*, *b*) differs from the Peruvian species in being more elongate posteriorly and in having more central umbones; *L. obesa* (**31,** pl. xxxiv, figs. 2*a*–*c*) is quite different in shape and inflation; and the Argentinian form is smaller, much shorter, differently shaped posteriorly, and with higher umbones.

Somewhat like *L. bellistriata* Stevens (**13,** pl. xxix, figs. 6*a*–*d*), especially those figured by Girty from Arkansas (**12,** pl. xiv, figs. 1–9*a*), *L. browni* differs in having its posterior end longer, wider in the dorso-ventral direction, a more evenly convex ventral margin, a lower inflation of the valves, and lower umbones, besides being much larger altogether.

L. basedowi Eth. fil. from Northern Territory, Australia (**4,** pl. vi, fig. 6), bears a close comparison to *L. browni*, but differs in its longer and less quadrate anterior end, and in its more elevated umbones.

Locality.—Goniatite Bed, Pariñas Quebrada.

Leda obesa var. *peruviana* nov.

(Pl. VI, Fig. 5; Pl. VII, Figs. 3, 3*a*.)

There are two specimens preserving part of the shell substance which, though very close to *L. obesa* White (loc. cit.), show certain differences from that species.

Diagnosis.—The valves are of moderate size, and are transversely elongate; the greatest height is below the umbones and is two-thirds of the length. Anterior end high, large, semi-oval: inferior margin gently convex: posterior end attenuated and rostrate, its height less than half that of the anterior end. The umbones are low, located a little anterior to the centre of the dorsal margin, and directed posteriorly. The dorsal margin posterior to the umbones is concave upwards, becoming straight posteriorly. The inflation is moderate.

A well-defined, rounded, curving ridge runs posteriorly from the umbo and separates from the rest of the valve a rather narrow concave area between it and the hinge-line. The lunule is faint and small; the escutcheon is long and narrow.

The ornamentation consists of numerous, closely-arranged, fine, concentric striae. In neither specimen where the shell has been removed can any furrow in the umbonal region be observed on the cast.

Remarks.—The Peruvian form is very similar to the North American species. It differs in the lower inflation of the former—this seems a quite constant difference, though it hardly justifies a more than varietal separation from *L. obesa*.

Locality.—Gramadal Quebrada (east limb of fold) about 3 miles from its junction with the Pariñas Quebrada.

FAMILY TRIGONIIDAE.

Genus Schizodus King.

Schizodus sp. cf. *meekanus* Girty.

(Pl. VIII, Fig. 3.)

There are three specimens belonging to one species which may be compared with *Schizodus meekanus* Girty. One is an internal cast of both valves, while both the others have the shell much exfoliated, though one shows part of the hinge apparatus.

Diagnosis.—The shell is large, ovate-triangular, posteriorly elongate; the anterior end is half the length of the posterior. Greatest height beneath the umbones about five-sixths of the greatest length. Inflation moderate, reaching a maximum at a distance from the umbo equal to one-third of the height. Umbones situated in the anterior half, prominent, large, tumid and opisthogyrous.

The anterior margin is smoothly rounded, nearly semi-circular, merging gradually into the ventral border which is gently convex and inclined dorsally. Posteriorly the shell is abruptly truncated, the margin being short and straight, and meeting at angles of about 80° and of about 155° respectively the inferior and dorsal borders. The latter is straight and half the length of the shell. The narrow area above the rounded dorsal ridge is gently concave.

Remnants of the external ornamentation show it to have consisted of fine, closely-arranged, concentric striae.

The hinge of the right valve consists of two teeth situated beneath the umbo, the teeth at an angle of 110° to each other. The anterior tooth is the larger and stouter of the two ; the posterior is inclined at a slightly smaller angle to the hinge-line and may have been fractured somewhat posteriorly. There is no indication of the third, nearly obsolete tooth which Hind (**14,** pp. 213–15) and Waagen (**29,** p. 232) identified in the right valve of the genus, but of which no recognition is made by Cossman (**1,** p. 66).

Those parts preserved as internal moulds show on each valve a well-defined curved groove running from the umbonal region towards the postero-inferior angle, and just anterior to the post-umbonal ridge, while the adductor muscle-scars are shown to be placed near the dorsal margin of the valves at a distance from the umbo equal to about two-fifths the height.

Remarks.—Derby (**2,** p. 496) mentions four species of *Schizodus* from the Carboniferous deposits of the Amazon Basin. One of them he refers doubtfully to *S. wheeleri* (Swallow), while another he records as being of the same type as that species but " different from any North American shell with which it has been compared ". It may be that one of these species, probably the first, is identical with the Amotape form.

The latter is very closely allied to, if not identical with, *S. meekanus* Girty (**7,** p. 583, pl. 72, figs. 7*a–c*) from the Upper Coal Measures of Indian Territory, and especially to those forms which Meek (**21,** pl. x, figs. 1*e, f*) and Keyes (**18,** pl. xlvi, figs. 3*a, b*) had earlier referred to *S. wheeleri* (Swallow),[1] but which Girty considered identical with his species. The similarity to Keyes's figures is very pronounced in size, shape, and in the characters shown on the casts—only slight differences exist in the larger anterior end, the greater height, and the more central umbones of the Peruvian form.

From Brazil *S.* sp. cf. *rossicus* de Vern. is recorded by Derby and Katzer (**17,** p. 180) ; de Verneuil's species is quite distinct.

Locality.—Sullana Road and " Ammonite " Valley (1½ miles south of El Muerto).

Schizodus sp. cf. *harii* Miller.

(Pl. VII, Figs. 7, 7*a*.)

A single well-preserved specimen may be compared with Miller's Pennsylvanian species.

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[1] Swallow's species is recorded from the Donetz Basin by N. Jakowlew in " Die Fauna der oberen Abtheilung der palaeozoischen ablagerungen im Donez-Bassin ", *Mem. Comm. Geol. Russ.*, N.S., Livr. 4, 1903, p. 15, pl. i, fig. 22.

Diagnosis.—Moderately large, suborbicular, and obliquely truncate posteriorly, the valves are very slightly unequal, the left valve being somewhat the higher. Length slightly greater than the height. The inflation is moderate, at a maximum at two-fifths of the height of the shell beneath the umbones, which are inflated, pointed, incurved, contiguous, mesogyrous, and situated at one-third the distance from the anterior margin.

The latter is semi-circular and passes evenly into the convex ventral border. The posterior margin is short, nearly straight, and truncated obliquely downwards and backwards, meeting the ventral border in a rounded, wide, obtuse angle. The hinge-line is short and arched, merging almost imperceptibly into the anterior and posterior margins.

The umbonal swelling is marked anteriorly by a very short, well-marked, rounded-angular ridge running downwards and forwards. From the posterior side of the umbo to the postero-inferior margin runs a low, rounded ridge—above it the valve is very slightly convex, but becomes concave by the umbo.

The surface ornamentation is not well shown, but it seems to consist of numerous, regular, fine, concentric growth-striae.

Dimensions.—Length = 48·0 mm. ; height = 40·5 mm. ; thickness = 27·5 mm.

Remarks.—The Peruvian form is very closely allied to, if not identical with, *S. harii* Miller (**24,** pl. xx, figs. 1–3). The small differences to be observed between the figures given by Miller and by Keyes (**18,** pl. xlvi, fig. 4) and also the specimen figured by Hind (**14,** pl. xvi, fig. 1), on the one hand, and the South American form on the other, lie in the slightly more inflated shell of the former, its more acute umbones, and their more posterior position, features which doubtless fall within the limits of variation of the species.

Locality.—Steel Hill, Pariñas Quebrada.

FAMILY PINNIDAE.

Genus Aviculopinna Meek.

Aviculopinna sp. cf. *peracuta* (Shum.).

(Pl. VII, Fig. 1.)

There is a single specimen, an internal cast lacking a small part of the umbonal region and of the posterior portion, which may be compared with Shumard's species. A fragment of another individual doubtless belongs to the same species.

Diagnosis.—The valves are large, triangular, and equal in size, with a moderate convexity, and a posterior gape. The hinge-line is long and straight, and forms the longest part of the shell. With it the long, nearly straight, ventral margin makes an angle of about 14°. The posterior margin, as shown by the growth-lines, curves anteriorly forwards from its junction with the hinge-line, the angle between them where they meet being about 55°. The curvature increases downwards and the posterior margin passes evenly into the inferior border.

The cast shows numerous, fine, concentric growth-striae, which are closely approximated at the ventral border. Just below the hinge-line, as well as just above the ventral margin, is a slight depression which runs the length of the valve. The ligament is internal, placed along the hinge-line.

Remarks.—Shumard (**28,** p. 214) unfortunately did not figure his specimen, but the Amotape cast compares very well with the figures of specimens referred to that species by Meek (**21,** pl. vi, figs. 11*a*, *b*) and by Keyes (**18,** pl. xlv, figs. 2*a*, *b*). Derby (**2,** p. 495) recorded fragments from Brazil referable to *A. peracuta* (Shum.) and the same species is referred to by Katzer (**17,** pp. 175, 176, 180). The reference of the species to *Aviculopinna* has been questioned by Girty (**8,** pp. 432, 433) on the score of the absence of radiating ribs and lamellose projections, and also because of the anterior downward direction of the posterior margin.

Locality.—Goniatite Bed, Pariñas Quebrada.

FAMILY COELONOTIDAE.

Genus ALLORISMA King.

Allorisma barringtoni sp. nov.

(Pl. VII, Figs. 5–6.)

This species is fairly common and occurs at two of the fossiliferous localities. The earth-pressures affecting the area have caused the shapes of the specimens to vary considerably.

Diagnosis.—The valves are large, equal in size, and very inequilateral; they are transversely elongated, rounded-rectangular, and obliquely tumid. The anterior end is short and deep, bounded by an almost straight margin in the upper part, but in the lower part curving regularly into the slightly convex ventral border. The posterior margin is gently curved, with the dorsal border straight or slightly concave and practically parallel to the inferior margin. The umbones are low, tumid, nearly terminal, and distinctly prosogyrous. The hinge is long and straight, and equal to about three-quarters of the length of the valves. The lunule is short and broad, and the escutcheon is long, narrow, and shallow.

The surface is marked by regular, fairly strong, simple, concentric, rounded ribs and sulci, the latter broader than the former, which become weaker on the dorsal slope. Numerous fine, concentric striae occur on the ribs and in the sulci.

Dimensions (of holotype).—Length = 68·5 mm.; height = 38·5 mm.; thickness = c. 32·5 mm.

Remarks.—Derby (**2,** p. 497) records from Brazil three species of *Allorisma* including *A. subcuneata* Meek and Hayden (**22,** p. 263), a second form which he states may be distinct from that species, and a third which is similar to *Edmondia* (?) *glabra* Meek. Katzer (**17,** p. 267, pl. viii, figs. 1, 1*a*) also records the first-named species. From that common North American Pennsylvanian species (**23,** p. 37, pl. i, figs. 10*a*, *b*), identical with *A. terminale* Hall—*vide* Girty (**8,** pp. 437, 438, pl. ix, figs. 4–6)—and from *A. capax* Newberry (**25,** p. 120, pl. i, figs. 9, 9*a*), the Amotape species differs in being relatively higher in proportion to its length. In a similar way it is distinguished from *A. maxima* (Portlock), with which Hind (**14,** p. 419) considered *A. subcuneata* to be synonymous. None other of the North American species can be usefully compared with the new species. It is rather suggestive of the European *A. sulcata* (Fleming), but lacks the compression in the valves of that species (**14,** p. 422), besides being larger.

Localities.—Sullana Road, 1½ miles south of El Muerto; Steel Hill, Pariñas Quebrada.

Allorisma baldryi sp. nov.

(Pl. VIII, Figs. 1, 1*a*.)

Diagnosis.—The valves are of medium size and are nearly rectangular in outline, with the low umbones almost terminal. The height is equal to three-fifths of the length and is greatest beneath the umbones. The inflation is moderate and is at a maximum at a little above the mid-height. In its upper half the anterior margin is straight, but its lower part, where the anterior end projects a little forwards, is regularly curved, and passes evenly into the long, slightly curved ventral margin. The latter passes by means of a rounded angle into the posterior border, which is nearly straight and sub-truncate. The dorsal margin is long and straight, and in the posterior direction is inclined slightly downwards. The postero-superior angle is obtuse.

In the anterior part of the shell a strong swelling runs vertically downwards from the umbo, and in front of this the valve descends rapidly to the anterior margin. Between this swelling and the dorsal slope the valves are almost flattened. The dorsal slope itself is slightly convex posteriorly, but it becomes concave near the umbo. The lunule is well-marked and broad, while the escutcheon is long and well-defined.

The ornamentation consists of numerous, rounded, fairly prominent, concentric ribs with broader sulci between them; the ribs in the posterior direction are inclined dorsally over most of the valve and tend to become obscure on the dorsal slope. In addition there are closely-arranged, fine, concentric striae both on the ribs and in the sulci.

Dimensions (of holotype).—Length = 47·0 mm.; height = 27·0 mm.; thickness = 22·0 mm.

Remarks.—This species is much smaller than the preceding one and is further distinguished from it by its more nearly straight ventral and dorsal margins, by their slight inclination towards one another, and by the somewhat projecting anterior end. There are no species with which it may be usefully compared.

Locality.—Gramadal Quebrada (east limb of fold) about 3 miles from its junction with the Pariñas Quebrada.

Allorisma amotapense sp. nov.

(Pl. VII, Figs. 4–4*b*.)

This species, of very well-defined characters, is represented by only one specimen, quite uncrushed, associated with *A. baldryi.*

Diagnosis.—The shell is of medium size, equivalve, sub-rectangular, inflated, the inflation at a maximum at the mid-height and at two-fifths of the length from the anterior border. The height is equal to one-half of the length. The umbones are very low, small, and almost terminal. The anterior end is very short, and its margin, in the upper part, practically vertical, but in the lower half it curves evenly into the slightly convex ventral margin. The posterior border is convex below, but straight and subtruncate above. It meets the dorsal margin in a wide obtuse angle; the latter is straight, shorter than the inferior margin, and equal in length to five-eighths of that of the shell. The lunule is broad and well-defined; the escutcheon is long and narrow, and bounded by a low rounded ridge.

The ornamentation of the valves consists of numerous, rather obscure, low, rounded ribs and sulci, which are almost obsolete on the dorsal slope.

Dimensions (of holotype).—Length = 47·0 mm.; height = 24·0 mm.; thickness = 19·5 mm.

Remarks.—This species is distinguished by its weak ornamentation from the rather similar *A. baldryi* with which it occurs. The two are clearly allied to one another.

Locality.—Gramadal Quebrada (east limb of fold), 3 miles from its junction with the Pariñas Quebrada.

Allorisma parinasense sp. nov.

(Pl. VIII, Figs. 6–6*b*.)

One well-preserved specimen from Steel Hill represents this species. It has undergone only slight compression, the effect of which is to emphasize to a very small extent the oblique, tumid nature of the valves, especially the left valve.

Diagnosis.—Equivalve, very inequilateral, and of medium size, the shell is almost quadrate in outline. The convexity is moderate, the greatest inflation occurring at the mid-height. The umbones are small, project somewhat above the hinge-line, and are placed near the anterior end. The hinge-line is long and straight, but less than the greatest length of the valves, and it has a well-rounded junction with the posterior margin. The latter is convex and merges evenly into the nearly straight ventral border, which is shorter than the hinge-line. The anterior margin is long and gently convex, becoming straight in the upper part. The lunule is small but well-defined; the escutcheon is narrow and appears to extend along only half the postero-dorsal margin.

The ornamentation consists of some twenty-four prominent, rounded, concentric ribs, which become obsolete in the escutcheon and in the lunule. The rounded sulci are from one and a half to twice the width of the ribs, and like them have imposed on them numerous, very fine, concentric striae, two to five to each rib or stria.

Dimensions (of holotype).—Length = 31·0 mm.; height = 26·0 mm.; thickness = 15·0 mm.

Remarks.—This species is easily distinguished from the others in the collection by its quadrate shape, and there does not seem to be any other with which it may be compared.

Locality.—Steel Hill, Pariñas Quebrada.

Allorisma (?) sp. ind.

(Pl. VIII, Fig. 4.)

Represented by the anterior part of the right valve, with a fragment of that of the left attached, is another species quite distinct from any other in the collection.

Diagnosis.—Valves transversely elongate, inequilateral, moderately compressed; greatest height below the umbo and *probably* one-half to one-third of the greatest length. Maximum inflation in the upper half of the valve. Umbones low, incurved, inflated, placed in the anterior part of the valves, but some distance from the anterior. Anterior margin regularly rounded; ventral border long, gently curved, and rising slightly in the posterior direction.

The external ornamentation consists of numerous, concentric, low ribs separated by shallow, broader sulci. Both ribs and sulci are ornamented with from two to four, fine, concentric striae. There are indications of the presence of a narrow lunule.

Remarks.—This species may belong to *Allorisma*, though its umbones are placed rather farther from the anterior border than is general in that genus. Alternatively, it may belong to *Sanguinolites*. Its finer ribbing distinguishes it from any of the species belonging to those two genera.

Locality.—Junction of Sullana Road and Pariñas Quebrada.

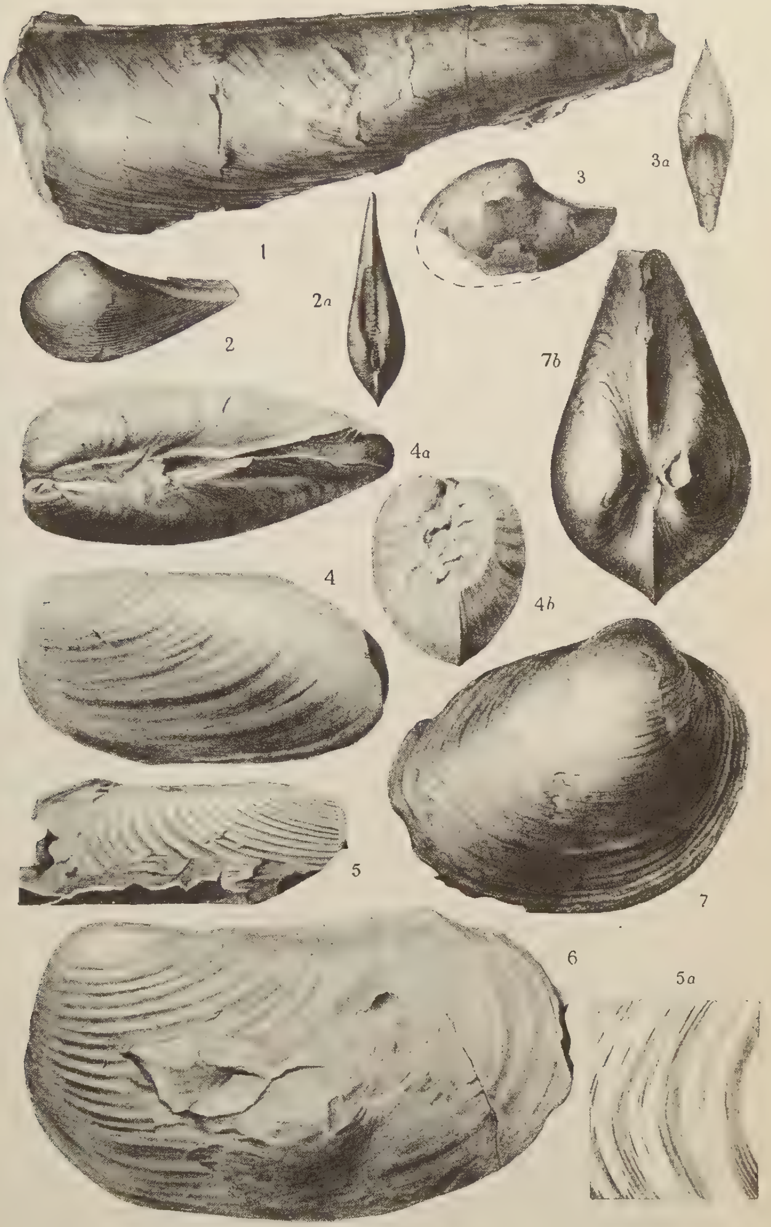
Genus Sanguinolites McCoy.

Sanguinolites ? *amotapensis* sp. nov.

(Pl. VI, Figs. 10, 10*a*.)

Only a portion of a left valve represents this species, but its characters are distinctive enough to warrant the erection of a new specific name for its reception.

Diagnosis.—The valve is moderately large, transversely elongate, and inequilateral, with the umbo placed between the anterior end



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PERUVIAN CARBONIFEROUS LAMELLIBRANCHIA.

[*To face p. 224.*

and the centre of the dorsal margin. The greatest height is below the umbo. The hinge-line appears to be straight, long, and less than the length of the valves. The umbones are high and prominent. The anterior margin is rounded, and, according to the growth-lines, passes regularly into the gently curving ventral border. A well defined but shallow depression which widens ventrally traverses the valve from the umbo almost vertically, and causes a slight concavity in the inferior margin.

The ornamentation consists of numerous, fairly strong, concentric ribs separated by broader rounded furrows. The ribbing becomes weaker near the anterior margin, where it is represented only by thin striae. As the ribs cross the dorso-ventral constriction they are in general deflected upwards. In one or two cases the deflection is more marked than in others and in the widened inter-space so formed a new rib is intercalated. In only one instance does a rib actually bifurcate posteriorly on crossing the constriction. Some of the later ribs also arise by bifurcation near the anterior margin, and passing backwards become almost as strong as the primaries. Fine concentric striae, up to four or five in number, are also present, and traverse the sulci. Posterior to the umbo is a well-defined rounded ridge, above which, as far as the escutcheon, the valve is concave, and lacking in the concentric ornamentation. A longitudinal groove traverses this concave area. The escutcheon is long and broad; the lunule is small.

Remarks.—This species, though appearing to belong to *Sanguinolites* M'Coy, is difficult to compare with other species of that genus. Its characters are strongly like those of the allied genus *Grammysia*, especially in the nature of the ribbing. It recalls also the form referred to *Sedgwickia topekaensis* ? Shum. by Meek and Hayden (**23,** p. 40, figs. A, B), and, to some extent, *Allorisma* (*Sedgwickia* ?) *reflexum* Meek (**21,** pl. x, fig. 15) and *Allorisma* ? *gilberti* White (**31,** pl. xxxiii, figs. 9*a*, *b*), but it is distinct from all of these.

Locality.—Goniatite Bed, Pariñas Quebrada.

Sanguinolites peruvianus sp. nov.

(Pl. VI, Figs. 7, 7*a*, 15; Pl. VIII, Fig. 2.)

Five specimens are included in this species from two localities. The holotype is a little larger than the others, and is almost undistorted.

Diagnosis.—Medium to large in size, the shell is equivalve, very inequilateral, very transverse, and moderately inflated. The greatest height occurs at about the mid-length and is equal to two-fifths of the length. The umbones are small, low, and very anterior, though not terminal. The anterior end is slight projecting and nearly semi-circular in outline, passing quite evenly into the long, gently curving, ventral margin. The postero-inferior angle is rounded, and the posterior border slightly curved. The dorsal margin is straight and equal to five-sevenths of the length of the valves. Its junction with the posterior border is rounded.

A well-defined, rounded ridge runs from the umbo towards the lower posterior angle. In specimens affected by crushing this swelling becomes emphasized and even angular, while the valves, which normally are rather flattened anterior to it, may appear to possess a shallow depression running vertically downwards from the umbones. The dorsal slope is nearly flat. There is a very narrow, long escutcheon bounded by a low rounded ridge; a small lunule may be present.

The surface ornamentation consists of numerous fine, closely-arranged, concentric striae, and of several somewhat stronger, growth-lines. The latter become weaker on the dorsal slope. The shell substance is thin.

In the anterior part of one specimen the shell is broken away, and the internal cast shows that the anterior adductor impression on the shell is very close to the anterior margin, is elongated in the dorso-ventral direction, and is bounded posteriorly by a vertical ridge.

Dimensions (of holotype).—Length = 60·5 mm.; height = 23·0 mm.; thickness = 17·5 mm.

Remarks.—This well-defined species belongs to the smooth-shelled group of *Sanguinolites*, a division of the genus already noted by Hind (**14,** p. 366). The presence of the escutcheon, of the posterior ridge on the valves, and of the ridge bounding the posterior margin of the anterior adductor are characters typical of *Sanguinolites*.

Localities.—Steel Hill, Pariñas Quebrada; and Sullana Road and " Ammonite Valley " ($1\frac{1}{2}$ miles south of El Muerto).

Sanguinolites inordinatus sp. nov.

(Pl. VI, Figs. 8–8*b*; Pl. VIII, Fig. 7.)

Two specimens represent this species—one is but a portion of the ventral half of the mollusc, while the other includes the anterior end of both valves, and extends slightly beyond the umbones.

Diagnosis.—Apparently the valve was moderately large, transversely elongate, very inequilateral, with the umbones in the anterior half of the shell. The umbones are very low, incurved, and, in the one specimen which shows them, directed posteriorly, but this is doubtless due, in part at least, to pressure, for the valve is somewhat distorted. The anterior margin is well-rounded, passing smoothly into the long, slightly convex ventral border. The hinge-line is straight and less then the greatest length of the shell.

The ornamentation of the valves is most extraordinary. From the anterior of the umbones there runs in a posteriorly oblique direction a shallow groove forming a line of division between the ribbing of the anterior end of the valve and that of the rest of the valve.

The former consists of about ten oblique, irregularly curved ribs inclined ventrally in the posterior direction, the later ones more convex than the earlier ones. The last-formed two ribs are parallel to the inferior margin and truncate those superior to them. The rest of the valve is ornamented with numerous more closely arranged V-shaped ribs, the angles of the V's forming a well-marked narrow depression running in an obliquely posterior direction from the posterior side of the umbo. The broad well-marked escutcheon shows no ribbing. The lunule is small. Crossing the ribs and unbroken by them are numerous, fine, concentric growth-striae.

Remarks.—In the absence of further specimens this curious species is referred to *Sanguinolites* from the general characters which can be determined, though the ornamentation is not of the usual type found in that genus. Indeed, interruption of the ribbing is not at all a common feature of lamellibranchia, though it is a typical character of *Goniomya.* The Permian species referred to the latter genus from Russia (**6,** pl. vi, fig. 23 ; **20,** pl. iii, fig. 20) and from the Himalayas (**3,** pl. v, fig. 19 ; pl. viii, fig. 11) are quite different from *S. inordinatus.*

Wheelton Hind described from the Redesdale Ironstone of Northumberland and from the Millstone Grit of Cheshire *S. v-scriptus* Hind (**14,** pl. xlii, figs. 5–7), which shows somewhat analogous ornamentation to the Peruvian species, viz. V-shaped ribs. Hind further remarks, " In full-grown shell, towards the lower margin in front the ribs may become broken a little, and their line somewhat irregular ", a feature very much more pronounced in *S. inordinatus.* Interruption of the ribs, or, if interruption is incomplete, V-shaped ribbing is also shown by *S. interruptus* Hind (**14,** pl. xlix, figs. 10, 10*a*).

In some respects *Grammysia ? carbonaria* Girty (**9,** pl. vi, figs. 11–13) from North America shows an ornamentation approaching that of the new species in that it shows truncation of ribs ; it differs, however, in the shape of the shell and in other details.

Locality.—Steel Hill, Pariñas Quebrada.

Sanguinolites pacificus sp. nov.

(Pl. VI, Fig. 9.)

Diagnosis.—The valves are inequilateral, transversely elongate, sub-rectangular, the length twice the height. The low umbones are placed at a distance equal to one-third of the length from the anterior end. The hinge-line is straight and long. The posterior margin is slightly rounded and sub-truncate. The ventral margin is nearly parallel to the dorsal border but gently convex, its junction with both the posterior and the rounded anterior borders being regularly curved. An oblique well-defined ridge traverses the valve from the posterior edge of the umbo to the postero-inferior margin. There appears to be a long, narrow escutcheon, and a small lunule.

The ornamentation consists of some ten or twelve rather strong concentric ribs which are obscure on the dorsal slope.

Remarks.—This species appears to belong to *Sanguinolites* rather than to *Allorisma* or *Edmondia.* It has no close affinities in the genus, though it is of the same type as *S. ovalis* Hind (**14,** pl. xlvi, figs. 14–17).

Locality.—Gramadal Quebrada (east limb of fold), about 3 miles from its junction with the Pariñas Quebrada.

Sanguinolites insolitus sp. nov.

(Pl. VI, Figs. 11–12.)

Two of the fossiliferous localities have yielded three specimens belonging to this species.

Diagnosis.—The shell is of medium size, equivalve, very inequilateral, rectangular, transversely elongate, the length being more than three times the height. The inflation is moderate, the maximum occurring at about the mid-height. The umbones are low, and placed near the anterior end of the long, straight hinge-line. The anterior margin is short and evenly rounded, with the ventral border long and gently convex. The posterior margin is sub-truncate and slightly convex, its curvature increasing downwards so that its junction with the ventral margin is rounded. The hinge-line is apparently edentulous. The lunule is short and narrow ; the escutcheon is long and well-defined, and is bounded by a rounded ridge with a groove parallel to it on the external side. A second broader groove traverses the centre of the dorsal slope, with a third shallower one between it and the rounded ridge which runs from the umbones to the lower posterior angle.

The ornamentation consists of numerous, fine, closely-arranged, concentric striae and of prominent rounded ribs. In the anterior part of the shell these latter are parallel to the lines of growth, but along a line running slightly posteriorly from the umbo towards the venter the ribs, except for the last-formed two or three, end abruptly. In general, between their ends new ribs are intercalated which traverse the fine striae in an oblique direction, running upwards posteriorly till they reach the post-umbonal swelling, where they curve slightly forwards and become parallel to the growth-lines. After crossing the furrow on the dorsal slope the ribs grow weaker and finally become obsolete. The concentric part of the two lowest ribs extends much farther back than that of the earlier ribs. The first of these longer ribs truncates five, and the second six, oblique ribs, the posterior one of which in each case bifurcates on reaching the dorsal slope.

Remarks.—This curious species appears to belong to *Sanguinolites,* though its ornamentation is not normal for that genus. There is no species which is comparable, except the associated form *Sanguinolites deportatus* sp. nov. (*vide inf.*), which is larger and less transverse.

Localities.—Goniatite Bed, Pariñas Quebrada; Steel Hill, Pariñas Quebrada.

Sanguinolites deportatus sp. nov.

(Pl. VI, Figs. 6–6*a*.)

Diagnosis.—Of medium size, the shell is equivalve, inequilateral, compressed, transversely elongate, height probably one-third of the greatest length. The umbones are low, incurved, inflated, and in the anterior part of the shell. The anterior end is apparently rounded. The ventral border is very gently convex, while the posterior margin is rounded, and makes a slightly obtuse angle with the straight dorsal border. Crossing the valves obliquely from the umbones in a postero-ventral direction is a low, rounded ridge separating the wide compressed dorsal slope from the rest of the valve. Two broad, rounded depressions traverse the slope from the umbo to the posterior margin, leaving a rounded plication between them.

The escutcheon is long and very narrow; fracture of the shell has removed any trace of the lunule, if such were present.

The ornamentation of the valve comprises ribs and striae. The ribs near the umbo are inflected, while the later ones are fairly strong, irregular, and V-shaped, the angles of the V's lying along a line running slightly anteriorly from the umbo to the ventral margin. In the posterior part of the valve the ribs may bifurcate or re-unite, but become obsolete on the dorsal slope. The concentric growth-striae are numerous and fine, and cross the ribs without any inflection.

Remarks.—It is unfortunate that the single specimen of this species is so fragmentary, since it is obviously new. It differs from *S. insolitus* sp. nov. in being larger, less transverse, and less inflated, while the ribbing is also somewhat different. It is possible those two species will be found, from further material, to belong to a new sub-genus of *Sanguinolites*.

Locality.—Goniatite Bed, Pariñas Quebrada.

Genus SOLENOMORPHA Cockerell.

Solenomorpha equatorialis sp. nov.

(Pl. VI, Fig. 14.)

This species is represented by two specimens from Gramadal Valley; one of them is badly crushed and exfoliated, but the other is fairly well preserved.

Diagnosis.—Valves of medium size, very transverse, and very inequilateral. The umbones are small, low, and nearly but not quite terminal. The anterior part is very short, is closed, and projects somewhat, while its margin is rounded. The posterior margin is obliquely sub-truncated, with a rounded junction with the inferior border. The latter is long, very gently convex, and almost parallel to, but slightly diverging posteriorly from, the long, straight dorsal margin. The height is equal to only one-quarter of the length, but increases very slightly posteriorly. A rounded swelling runs transversely across the valves from the umbones to the postero-inferior angle. The surface ornamentation consists of closely-arranged, very fine, concentric striae.

Dimensions (of holotype).—Length = c. 45·0 mm.; height = 13·0 mm.; thickness = c. 10·0 mm.

Remarks.—Derby (**2,** p. 497) records from Brazil a species of *Solenomorpha* which has " a general resemblance to *S. solenoides* Geinitz, from which it is distinguished by being wider posteriorly than anteriorly ". The Peruvian species differs from the Nebraskan shell (**5,** p. 25, pl. ii, fig. 7) in the same way as does the Brazilian species. Katzer (**17,** pp. 166, 183) merely mentions *Solenopsis* sp. (= *Solenomorpha* sp.) without commenting on the characters. None of the species from South Brazil referred to the genus by Holdhaus (**16**) offers any close comparison with the new species. *S. nitida* (Girty) is distinguished by its narrowing posterior end (**11,** p. 223), while *S. nitida* (?) (Girty), from the Moorefield Shale of Arkansas (**10,** p. 81, pl. xii, fig. 12), though having its dorsal and ventral margins practically parallel, is relatively shorter. The European forms, *S. minor* (M'Coy) and *S. major* Hind, are of quite different shape (**14, 15**), while *S. parallela* (Hind) is compressed (**14**), whereas the South American form is rather tumid.

Locality.—Gramadal Quebrada (east limb of fold), 3 miles from its junction with the Pariñas Quebrada.

FAMILY SOLEMYACIDAE.

Genus Clinopistha Meek and Worthen.

Clinopistha ? parinasensis sp. nov.

(Pl. VI, Figs. 13, 13*a*.)

There is only one specimen of this species in the collection; it has both valves fairly well preserved.

Diagnosis.—The shell is small, oval-rectangular, and inflated. The umbones are low and inflated, and placed in the posterior third of the shell. The posterior end is nearly straight and inclined in its upper part, but convex below. The inferior margin is nearly straight, but very slightly concave in its central part, due to an obscure depression which runs almost vertically downwards from the umbo, broadening towards the ventral border. The anterior border is convex, and the hinge-line straight. A well-marked swelling runs from the umbo towards the lower anterior angle. There appears to be a small escutcheon present. The surface is ornamented with very fine concentric striae.

Dimensions (of holotype).—Length = c. 25·0 mm.; height = 13·5 mm.

Remarks.—This species may belong to *Clinopistha*, though it recalls certain species of *Solenomya*, e.g. *S.* (?) *naenia* (Walcott) (**30**, pl. xix, fig. 9), *S. excisa* de Kon. (**19**, pl. ix, figs. 13, 14; pl. xxiii, figs. 30, 39, 40, 42, 43). It, however, seems to lack the gape characteristic of that genus, and is wanting also in the radiating ribs which occur in the typical species, though they are not present in all.

Locality.—Gramadal Quebrada (east limb of fold), about 3 miles from its junction with the Pariñas Quebrada.

FAMILY PLEUROPHORIDAE.

Genus Astartella Hall.

Astartella meridionalis sp. nov.

(Pl. VIII, Figs. 5, 5*a*.)

Ten specimens belonging to this species occur among the Peruvian fossils. The holotype, the only individual of the species from Steel Hill, is very well preserved and uncrushed.

Diagnosis.—Equivalve, inequilateral, sub-rectangular, and compressed, the shell is transversely elongate and truncated posteriorly. The length is four-thirds of the height, which is at a maximum below the umbones. The latter are conspicuous, somewhat inflated and placed at about one-fourth of the length from the anterior end. The anterior margin is convex merging evenly into the gently convex and dorsally inclined ventral border. The posterior margin is short, straight, inclined, and obliquely truncated, meeting the inferior border at an angle slightly greater than a right angle and the hinge-line at an angle of about 130°. The latter is long and straight, but less than the length of the valve. The escutcheon is long and narrow; the lunule is short and broad. Traversing each valve from the umbo to the postero-inferior angle is a well-marked rounded ridge. The dorsal slope is narrow with a well-defined, shallow, median depression along it.

The ornamentation consists of numerous, closely-arranged, evenly spaced, sharp, concentric ribs, the holotype having about forty of these.

Dimensions (of holotype).—Length = 18·0 mm.; height = 13·5 mm.; thickness = 7·5 mm.

Remarks.—In its characters there is no doubt of the generic reference of this species. It differs from all the other American species, including *A. antiqua* (d'Orb.) from Bolivia (**26**, p. 44, pl. iii, figs. 12, 13), in being more elongated and in possessing more numerous and lower ribs.

Localities.—Steel Hill, Pariñas Quebrada; Sullana Road and "Ammonite" Valley (1½ miles south of El Muerto).

EXPLANATION OF PLATES VI–VIII.

All the figures are of the natural size, except where otherwise stated.

Plate VI.

Fig.

1.—*Nucula* sp. cf. *anodontoides* Meek? Left valve, × $\frac{3}{2}$. Goniatite Bed, Pariñas Quebrada.

1*a*.—Do. Dorsal view.

1*b*.—Do. Umbonal region, showing the muscular system, × $\frac{5}{2}$.

2.—*Leda browni* sp. nov., holotype. Right valve. Same locality.

2*a*.—Do. Dorsal view.

3.—Do. A well-preserved internal mould. Same locality.

3*a*.—Do. Dorsal view of same specimen.

4.—Do. Internal mould of a young individual showing the impression of the hinge-apparatus, × $\frac{5}{2}$. Same locality.

5.—*L. obesa* var. *peruviana* nov. A right valve, somewhat crushed. Gramadal Quebrada, about 3 miles from its junction with the Pariñas Quebrada.

6.—*Sanguinolites deportatus* sp. nov., holotype. A broken right valve. Goniatite Bed, Pariñas Quebrada.

6*a*.—Do. Dorsal view.

7.—*S. peruvianus* sp. nov., holotype. Left valve. Steel Hill, Pariñas Quebrada.

7*a*.—Do. Dorsal view.

8.—*S. inordinatus* sp. nov., holotype. Right valve. Same locality.

8*a*.—Do. Dorsal view.

8*b*.—Do. Part of the ornamentation, × $\frac{5}{2}$.

9.—*S. pacificus* sp. nov., holotype. Left valve. Gramadal Quebrada, about 3 miles from its junction with the Pariñas Quebrada.

10.—*S.*? *amotapensis* sp. nov., holotype. Left valve. Goniatite Bed, Pariñas Quebrada.

10*a*.—Do. Part of the ornamentation, × $\frac{5}{2}$.

11.—*S. insolitus* sp. nov., holotype. Left valve. Same locality.

11*a*.—Do. Dorsal view.

12.—Do. Dorsal view of another specimen. Steel Hill, Pariñas Quebrada.

13.—*Clinopistha*? *parinasensis* sp. nov., holotype. Right valve. Gramadal Quebrada, about 3 miles from its junction with the Pariñas Quebrada.

13*a*.—Do. Dorsal view.

14.—*Solenomorpha equatorialis* sp. nov., holotype. Right valve. Same locality.

15.—*Sanguinolites peruvianus* sp. nov. Right valve of another specimen. Steel Hill, Pariñas Quebrada.

Plate VII.

Fig.

1.—*Aviculopinna* sp. cf. *peracuta* (Shum.). Right valve, × $\frac{2}{3}$. Goniatite Bed, Pariñas Quebrada.

2.—*Leda browni* sp. nov. The left valve of a young individual, × 2. Same locality.

2*a*.—Do. Dorsal view, × 2.

3.—*L. obesa* var. *peruviana* nov., holotype. Left valve, × $\frac{4}{3}$. Gramadal Quebrada, about 3 miles from its junction with the Pariñas Quebrada.

3*a*.—Do. Dorsal view, × $\frac{4}{3}$.

4.—*Allorisma amotapense* sp. nov., holotype. Left valve. Same locality.

4*a*.—Do. Dorsal view.

4*b*.—Do. Anterior view.

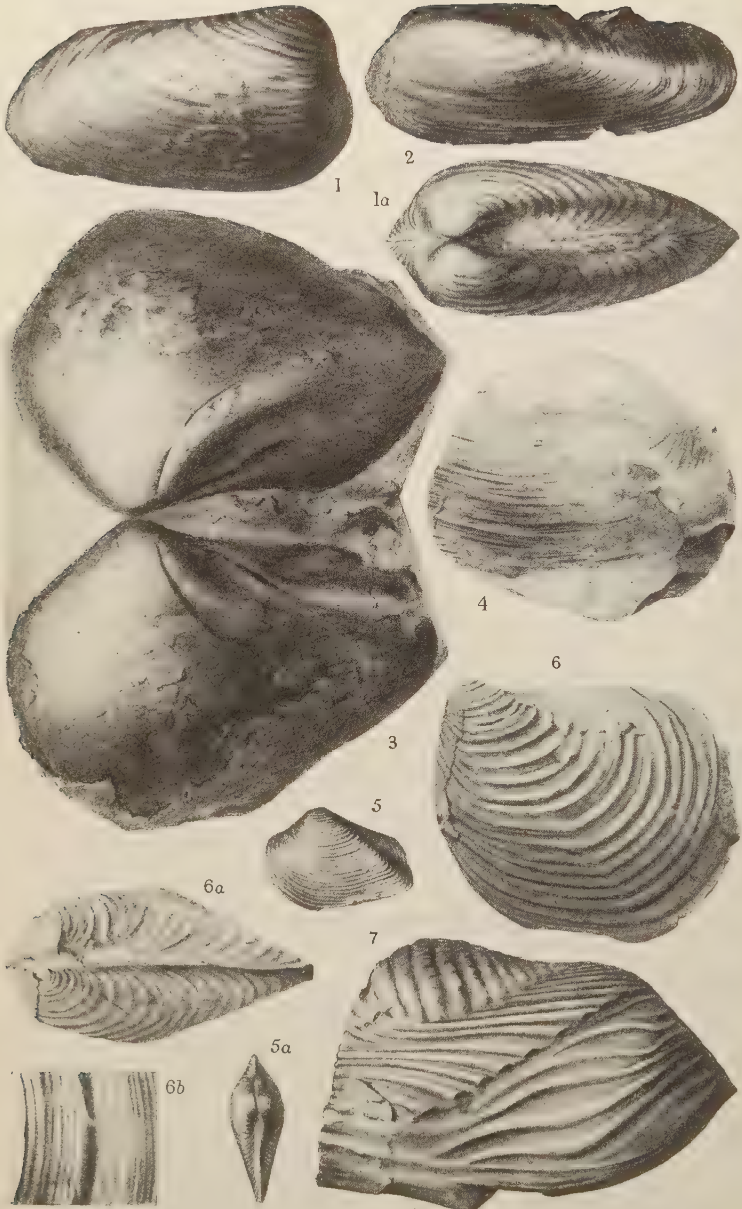
5.—*A. barringtoni* sp. nov. A broken right valve, showing the finer ornamentation. Sullana Road and "Ammonite" Valley, 1½ miles south of El Muerto.

5*a*.—Do. Part of the ornamentation, × $\frac{10}{3}$.

6.—*A. barringtoni* sp. nov., holotype. Left valve. Same locality.

7.—*Schizodus* sp. cf. *harii* Miller. Right valve. Steel Hill, Pariñas Quebrada.

7*b*.—Do. Dorsal view.



C.B.B. and E.T.T. del.

PERUVIAN CARBONIFEROUS LAMELLIBRANCHIA.

To face p. 233.]

Plate VIII.

Fig.

1.—*Allorisma baldryi* sp. nov., holotype. Right valve. Gramadal Quebrada, about 3 miles from its junction with the Pariñas Quebrada.
1*a*.—Do. Dorsal view.
2.—*Sanguinolites peruvianus* sp. nov. A slightly crushed specimen. Sullana Road and "Ammonite" Valley, 1½ miles south of El Muerto.
3.—*Schizodus* sp. cf. *meekanus* Girty. Same locality.
4.—*Allorisma* ? sp. ind. A part of a right valve, × $\frac{4}{3}$. Sullana Road and Pariñas Quebrada.
5.—*Astartella meridionalis* sp. nov., holotype. Left valve. Steel Hill, Pariñas Quebrada.
5*a*.—Do. Dorsal view.
6.—*Allorisma parinasense* sp. nov., holotype. Left valve, × $\frac{4}{3}$. Same locality.
6*a*.—Do. Dorsal view, × $\frac{4}{3}$.
6*b*.—Do. Part of the ornamentation, × 3.
7.—*Sanguinolites inordinatus* sp. nov. A broken right valve, × $\frac{4}{3}$. Same locality.

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(To be continued.)

REVIEWS.

JOURNAL OF THE MANCHESTER GEOLOGICAL ASSOCIATION, Vol. I, Part I, 1925–6.

We are pleased to be able to notice the appearance of the first number of the journal of the above Association, which was formed in 1925. The foreword gives a short history of the events which led up to the formation of this Association, which is a revival of the purely geological branch of the old Manchester Geological Society of nearly a century's standing.

The present number includes the address of the first president, Professor O. T. Jones, and three papers on the Carboniferous Rocks of Derbyshire and Lancashire.

Professor Jones takes for his theme "The Foundations of the Pennines", and after describing certain aspects of the distribution of the Lower Palaeozoic rocks in Wales and the Midlands in their relationship to the Stretton fault line, he draws comparisons between North Wales and the Lake District and thus deduces the probable structure and composition of the foundations of the main rigid mass of the Pennines from the known features of parts of the Midlands.

The Carboniferous papers are on "The Succession below the Kinder Scout grit in North Derbyshire", by J. Wilfrid Jackson; "The Carboniferous Rocks of the Stonyhurst District", by Rev. G. Waddington, S.J.; "The Carboniferous Sequence between Lothersdale and Cowling", by A. Bray. All these papers use the modern goniatite method with considerable success, Mr. Jackson proving an important unconformity between the Edale Shales and the Carboniferous Limestone; Father Waddington puts another nail in the coffin of the Pendlesides as a stratigraphical term, while Mr. Bray gives a detailed map and account of the stratigraphy of the beds between the Lower Coal Measures and the Main Limestone, which total a thickness of some 7,500 feet in this district.

From the standard set in this first volume it is clear that this Journal will be a worthy competitor with its sister publications on the other side of the Pennines as an outlet for pure geology of both a local and general type.

CATALOGO DESCRIPTIVO DE LAS MUESTRAS DE ALGUNAS MINAS DE ANTIOQUIA Y CALDAS. By R. LL. CODAZZI. Biblioteca del Museo Nacional, Bogotá, pp. 32. Bogotá: Imprenta Nacional, 1926.

IT is evident that the Administration of the Republic of Colombia is fully alive to the importance of spreading a knowledge among the general public of its mineral riches, a most praiseworthy object. This small pamphlet, which is in the main a descriptive catalogue of a particular collection in the National Museum, is prefaced by an excellent disquisition, written in simple language, on the general distribution of ores in the Cordillera Central of the Andes within the Republic, with an explanation of the more common technical and descriptive terms in general use, intended not for specialists, but for students of mining, together with brief descriptions of the more important minerals, and of some of the principal mines. The weakest point of the catalogue is the paper on which it is printed, which will not stand much wear and tear. Otherwise it is a most commendable production.

R. H. R.

GEOLOGICAL MAP OF EUROPE, executed under the direction of JOSEPH PRESTWICH, F.R.S., by W. TOPLEY and J. G. GOODCHILD. About 22 × 16½ inches, mounted on linen to fold. Oxford University Press, 1928. Price 2*s*. 6*d*.

A NEED has long been felt for a small and cheap geological map of Europe; the Oxford University Press has been most happily inspired to re-issue the map that accompanied Sir Joseph Prestwich's well-known book, a map which had probably in most cases escaped the knowledge of the present generation of geologists. The scale is of course small, but the number of different colours used is likewise small, only the Carboniferous system being subdivided into upper and lower, for the sake of the Coal-measures, while the whole of the Lower Palaezoic is shown by one colour. Consequently the map is really very clear. It brings out admirably the essential contrast between the simplicity of eastern Europe, and the extraordinary complexity of the south and west, a contrast which is of real significance, and not based merely on less complete knowledge of the eastern half. We venture to predict that this map will have a large sale and will do much to diffuse a knowledge of the general stratigraphy of Europe among students of the science.

An Examination of the Tertiary and Quaternary Changes of Sea-level in South Africa. By A. V. Krige. *Ann. Univ. Stellenbosch*, vol. v, Section A, No. 1, pp. 81, with 5 plates and a folding map, 1927.

THE work here described arose out of a conversation with Professor R. A. Daly in 1921. In the course of it the author has traversed something like 1,800 miles of coast-line on foot, by bicycle, on horseback, or by motor, some of the travelling being very difficult. The results can best be explained by a condensed extract from the "Conclusion."

Intermittent emergence has affected South Africa since early Tertiary time. The chief terraces, due to pauses, are at 4,000, 2,500, and 1,000 to 800 feet respectively, and smaller ones at roughly 550–450 and 250–150 feet. The emergence continued so far as to lay bare part of the Agulhas Bank and possibly went on till the present 400 fathom line formed the coast. Finally, after a period of Pleistocene and Recent drowning, another emergence left strand-marks and river-terraces at 50–60 and 20 feet respectively. The last raised beach deposits are correlated with Daly's negative eustatic shift due to the Glacial Period, which thus receives strong support from South Africa; several species of shells from the 20 ft. beaches are now found only in warmer waters.

REPORTS AND PROCEEDINGS.

Glasgow Geological Society.

12th January, 1928.

"Radioactivity and Continental Drift." By Professor Arthur Holmes, University of Durham.

The hypsometric curve was interpreted by Wegener to indicate the existence of two dominant kinds of materials in the earth's crust, *sial* corresponding to the lighter continental areas, and *sima* to the denser oceanic floors. This view has now been confirmed by the results of a study of surface seismic waves made by Hiller. The properties of the sima of the Pacific floor correspond to those of gabbro. The effect of compression on gabbro would be, not to produce mountains, but to transform the material into the high-pressure facies, eclogite. Such change of density and the simultaneous action of isostasy would lead to subsidence of the compressed belt and therefore to the formation of oceanic deeps. Applying the principle of isostasy to successive pairs of contrasted columns of the crust, it is easily shown that the average thickness of the sial of the continents should be about 30 km. or a little over. This conclusion agrees exactly with the results of recent work by Jeffreys on near earthquakes. These reveal the existence of an *upper layer* 10 km. thick (identified with granitic rocks); an *intermediate layer* 20 km. thick (supposed by Jeffreys to be tachylyte, but identified by Holmes with diorite and quartz-diorite on petrological and thermal grounds), and finally a *lower layer* or substratum which may be eclogite or peridotite or both. The continents are thus to be regarded as thin slabs of sial having a range in composition from granite to diorite, averaging 30 km. thick by about 3,000 km. across, and embedded in and underlain by material which on any interpretation is definitely much more dense than sial.

Thus, for sound physical reasons it becomes as impossible to "sink" a continent as it would be to sink an iceberg floating in the sea. We know that the sites of considerable areas of the Atlantic and Indian oceans were formerly occupied by continental masses, and since these ancient lands are no longer there we are driven to believe that their material has been moved away sideways. Evidence of lateral movement is also forthcoming from tear faults; overthrust structures of the Alpine type; the geological history of geosynclines; the echelon structures of the Asiatic island festoons; and perhaps most convincingly of all by the opening of the Urals geosyncline at the same geological moment as that which saw the compression of the Caledonian mountains of Britain and Scandinavia. Moving the continental regions back in the directions indicated by the evidence leads to a Permo-Carboniferous reconstruction similar to that made familiar by Wegener's diagrams, a reconstruction which is quite independently called for on palaeo-climatic grounds. Wegener's deduction that the equator of the time ran through the coalfield belt from North America to China is supported by the distribution of Permo-Carboniferous laterites and bauxites. It is concluded that there is now convincing evidence pointing to the former occurrence of continental drift on a scale of the same order as that advocated by Wegener.

Many geologists have hesitated to accept this straightforward and consistent reading of the rocks, because so far it has not been found possible to discover any gravitational force adequate to move the continental slabs in the required directions outwards from Africa towards the Pacific. The dominant forces available tend to set up (*a*) a westerly drift (due to tidal action), and (*b*) a drift from the poles towards the equator (due to the departure of a polar section through the earth from a circle). Jeffreys has recently shown that, given no strength in the substratum, the present viscosity which resists the movement is such that it would take about 3,000 million years for the whole crust to become symmetrical about the equator.

The earth's igneous history suggests that the average viscosity in the past has often been far lower than the present value; whence it follows that there has been time enough for these gravitational forces to have achieved their full effects. Since our actual geography is totally different from the picture thus visualized, we have again an indication that some other agency must have been at work to move the continents into the places they now occupy.

Admitting that the continents have drifted, there seems no escape from the deduction that slow but overwhelmingly powerful currents must have been generated in the underworld at various times in the earth's history. In Joly's hypothesis movements due to expansion and contraction are taken fully into consideration, but the only lateral movements considered are those due to tidal action leading to a westerly lag of the whole outer crust. There remains to be considered a happy suggestion which we owe to A. J. Bull, namely that convection currents may be set up in the lower layer as a result of differential heating by radioactivity. In place of the mobile basaltic magma of Joly, one imagines a highly viscous sima heated unequally down to very great depths. A sheet-like upward current would develop beneath the region of greatest heat output. In turning over at or near the base of the sial it would exercise a powerful drag on the undersurface in two opposed directions, thus leading to the formation of a geosyncline. The return downward current would be naturally looked for just beyond the continental edges. A continental mass would be enabled to move forward by stoping of the heavy ocean floor immediately in front. As this proceeded, mountain building would set in, and ultimately the direction of the currents would be reversed. Convection currents which themselves move their boundaries and the sources of much of the heat responsible for their existence can clearly lead to periodic alternations of heating and cooling in any one region. The particular mechanism advocated by Joly for bringing about alternate accumulation and discharge of heat appears to be unsatisfactory by itself because (*a*) it would lead to abnormal heating of ocean water (this follows if there is no light layer over the Pacific floor); (*b*) it does not explain the great amplitude of movement implied in Alpine structures; (*c*) it is inconsistent with the simultaneous occurrence of tension in the Urals with compression of the Caledonian mountains; (*d*) it does not account for the apparent drift of continental masses radially outwards towards the Pacific and the Tethys in both the northern and the southern hemispheres; (*e*) it has not yet been stated in terms satisfactory to mathematical physicists. It is thought that all these difficulties may be avoided by a development of the conception of large-scale convection currents in stiff material from which the more mobile portions are squeezed out as magmas.

OBITUARY.

Sir Aubrey Strahan, K.B.E., Sc.D., F.R.S.

By the death of Sir Aubrey Strahan we lose another of our leading geologists, one who devoted his life to the promotion of our science. He was educated at Eton and St. John's College, Cambridge, and graduated in the Natural Science Tripos in 1874. Shortly afterwards he joined H.M. Geological Survey, on which he remained till his retirement in 1920.

Most of his geological work was done in connection with that service. He devoted himself wholeheartedly to the work and was equally successful on the scientific and administrative sides. As a geological surveyor he was ideal: never influenced by hypothetical considerations, his maps were absolutely trustworthy. Equally valuable were his contributions to the *Survey Memoirs*. A vast amount of labour was devoted to these, whether recording his own work or editing that of others.

The greater part of his survey work dealt with areas in the north of England and in North and South Wales. This work was officially recognized in 1913, when on the retirement of Sir Jethro Teall he was appointed Director of the Survey. His work in the South Wales coalfield naturally turned his attention to economic matters in connection with coal, and as a member of the Royal Commission on Coal Supplies of 1905 he contributed much valuable material embodied in its Report. He devoted great attention to the distribution of concealed Coal-measures below the newer rocks of Great Britain, and published much on the matter, including his Presidential Addresses to Section C of the British Association in 1904 and to the Geological Society of London in 1913. He also conducted an important research into the present rate of denudation in certain English rivers, the results of which were published in various volumes of the *Geographical Journal* in the years 1908–11.

Perhaps Sir Aubrey's most striking characteristic was his well-balanced judgment. He had no axe to grind, and everything he wrote was put forward with conciseness, accuracy, and impartiality. He received many honours, being elected a Fellow of the Royal Society in 1903, was President of the Geological Society in 1912–14, was awarded the Wollaston Medal in 1919, and partly in recognition of his valuable services during the war in connection with the preparation and publication of the Special Reports on the Mineral Resources of Great Britain he received the K.B.E.

CORRESPONDENCE.

THE ORIGIN OF THE DWYKA CONGLOMERATE.

Sir,—There would appear to be something abnormally stimulating in the Geology of South Africa, of a kind indeed to stir the imagination of certain of its disciples, for only thus is one to explain Dr. Sandberg's whole-hearted resurrection in your March number of the long-abandoned idea of the volcanic origin of the celebrated Dwyka " Conglomerate ".

Dr. Sandberg has quoted widely from my writings and has conjured up curious difficulties therefrom, but from the nature of his arguments I am reluctantly led to doubt whether much, if anything, is to be gained through attempting to dispose of his criticisms point by point.

Providentially, however, a splendid opportunity for testing these two rival hypotheses will be presenting itself in 1929 through the meeting of the International Geological Congress in South Africa, when it will be our inestimable privilege to conduct a concourse of geologists, drawn from all parts of the globe and including vulcanologists as well as glaciologists, over what it is hoped will be admitted by Dr. Sandberg as representative sections of the Dwyka Series. To no higher or more impartial authority could appeal be made, and I shall be well content to transfer this engrossing problem to the consideration and judgment of the members of the Congress.

Alex L. du Toit.

Kimberley,
South Africa.
28*th March,* 1928.